PHILIPS

HEARTSTART

HEARTSTART XLT

Service Manual

M3500B/
M5500B

Service Manual

M3500B HeartStart XLT/
M5500B Heartstart 4000
Defibrillator/Monitor

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Notice

About This Edition

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The information in this manual applies to the M3500B HeartStart XLT Release Main 34 and earlier, and to the Heartstart 4000 Release Main 34 and earlier. This information is subject to change without notice.

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WARNING

Radio Frequency (RF) interference from nearby transmitting devices may seriously degrade performance of the M3500B/M5500B defibrillator/monitor. Electromagnetic compatibility with surrounding devices should be assessed prior to using the defibrillator.

CAUTION

Use of supplies or accessories other than those recommended by Philips Medical Systems may compromise product performance.

THIS PRODUCT IS NOT INTENDED FOR HOME USE.

IN THE U.S., FEDERAL LAW RESTRICTS THIS DEVICE TO SALE ON OR BY THE ORDER OF A PHYSICIAN.

Medical Device Directive

The M3500B/M5500B Defibrillator/ Monitor complies with the requirements of the Medical Device Directive 93/42/

EEC and carries the CE 0123 mark accordingly.

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Conventions

This manual uses the following text conventions:

NOTE	Notes contain additional information on servicing this product.
CAUTION	Caution statements describe conditions or actions that can result in damage to the equipment or loss of data.
WARNING	*Warning statements describe conditions or actions that can result in personal injury or loss of life.*

Text	represents messages that appear on the display
Softkey	represents softkey labels that appear on the display above or below the button to which they correspond

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1 Introduction

This Service Manual provides the information needed to successfully service the Philips M3500B HeartStart XLT and the Laerdal M5500B Heartstart 4000 Defibrillator/Monitors. The intended users of this manual are technical personnel who have been trained in the safe and proper servicing of the M3500B/M5500B.

Overview

In this chapter, you'll find general information that you should become familiar with before servicing the M3500B/M5500B. Detailed information regarding controls, operation, and capabilities of the instrument can be found in the ***Instructions for Use*** that was shipped with the product. We recommend you review the ***Instructions for Use*** before servicing this device. This Service Manual assumes you are familiar with the controls and with basic operations.

Defibrillator/Monitor

The M3500B/M5500B is a biphasic, semi-automatic external defibrillator. This portable, lightweight device offers two modes of operation for defibrillation:

- Semi-Automatic External Defibrillation (AED) Mode
- Manual Mode

In AED Mode, the M3500B/M5500B analyzes the patient's ECG and advises the clinician whether or not to deliver a shock. In Manual Mode, the M3500B/M5500B turns control of the defibrillation process over to the clinician. The clinician analyzes the patient's ECG, decides if defibrillation is advised, and determines the energy setting for defibrillation. Manual Mode also allows the clinician to perform synchronized cardioversion and offers optional noninvasive pacing (using a monophasic waveform).

Defibrillation is performed through multifunction defib electrode pads. In addition, both AED and Manual Mode offer monitoring through pads, 3-lead ECG monitoring electrodes, or optional 5-lead ECG monitoring electrodes. Optional pulse oximetry (SpO_2) monitoring is available in both modes, as well.

The M3500B/M5500B automatically stores critical events, such as shocks and alarm violations, in its internal memory. An Event Summary may be printed at any time. The M3500B/M5500B also enables you to store data and events on an M3510A/M5510A Data Card for downloading to the Event Review Data Management System.

Batteries, Power Modules, Battery Charger Adapter

The M3500B/M5500B is powered by a rechargeable Sealed Lead Acid (SLA) battery (M3516A/M5516A). Proper care of these batteries will ensure that they have the energy required to operate the M3500B/M5500B and deliver the appropriate therapy (See "Battery Maintenance" section in ***Instructions for Use***).

Batteries may be charged either in the defibrillator or in the Battery Charger Adapter (M3506A/M5506A). In either case, power for charging can be provided by the AC Power Module (M3517A/M5517A), or by the DC Power Module (M3518A/M5518A).

NOTE

The defibrillator will take longer to charge when powered with either power module without a battery installed. The recommended practice is to use a battery in conjunction with the power module to ensure optimal performance.

For information on either the power modules or the adapter, see the documentation supplied with the power module or adapter.

Installation

The M3500B/M5500B does not require installation. The ***Instructions for Use*** describes the setup required before placing the device into service, as well as configuration options.

Upgrades

Upgrades are available to add specific functionality to units in the field. As of the publication of this manual, these upgrades are:

- M3514A Pacing Upgrade (adds pacing)
- M3515A SpO2 upgrade.

Consult your sales representative or dealer or distributor for the latest details.

Preventive Maintenance

Preventive maintenance and periodic operational checks are intended to be performed by the user. Both topics are covered in the Maintenance chapter of the ***Instructions for Use***.

Repair Philosophy

Defibrillator/Monitor

The repair philosophy of the M3500B/M5500B is subassembly replacement. Examples of subassemblies are the printer, the Control Printed Circuit Assembly (PCA), and selected connectors and other items. Repairs that involve replacing components on a PCA are ***not*** supported.

CAUTION

Individual component replacement should *not* be attempted outside of a factory authorized repair facility. Component level repair is extremely difficult due to the extensive use of surface mount technology and the high parts-density on the circuit boards. Unauthorized component replacement can impair performance of the M3500B/M5500B.

Batteries, Power Modules, Battery Charger Adapter

The repair philosophy for the SLA battery (M3516A/M5516A), AC Power Module (M3517A/M5517A), DC Power Module (M3518A/M5518A), and the Battery Charger Adapter (M3506A/M5506A) is unit replacement. These accessories are not repaired in the field.

For information on ordering replacements, see "Supplies & Accessories" on page 5-16.

2 Performance Verification and Safety Tests

Overview

This chapter describes the tests and inspections required to verify performance of the M3500B/M5500B Defibrillator/Monitor.

The information is presented in the following sequence:

Test Matrix	A list of the tests required to verify performance of the M3500B/M5500B, along with expected test results.
Test Equipment	A list of commercially available test, calibration and simulation devices needed to perform performance verification tests.
Performance Verification	Step-by-step instructions for performing each of the Performance Verification Tests.

Mandatory Testing

The Performance Verification Tests in this chapter are intended to verify proper operation of the M3500B/M5500B following repair. The level of testing required corresponds to the type of repair performed, and is divided into 3 categories:

- External/No Trouble Found
- Printer
- Internal

External Repairs/No Trouble Found

External Repairs are those involving the repair or replacement of one or more of the items below. **No Trouble Found** applies when no malfunction can be found, or when the problem appears to be due to improper use. In either situation, the key point is that ***the case has not been opened.***

- ECG cable
- SpO_2 cable or sensor
- Battery

- Labels
- AC or DC Power module
- Consumables (ECG monitoring electrodes, multifunction defibrillation pads, printer paper)
- Main fuse (on Battery PCA)
- Manual Door Assembly
- Data Card Door Assembly
- Battery Eject Assembly

The following testing is required after an **External Repair** or when the outcome of the service is **No Trouble Found** ***(when the case has not been opened)***:

- Perform the Visual Inspection (page 2-12).
- Run the Extended Self Test (page 2-17).
- Print and Verify the System Log (page 2-16).

Printer

If the printer was replaced, ***and the case was not opened,*** the following tests are required:

- Perform the Visual Inspection (page 2-12).
- Run the Extended Self Test (page 2-17).
- Run the Printer Test (page 2-21).
- Print and Verify the System Log (page 2-16).

Internal Repairs

If the case was opened (regardless of what the repair involved), all of the Performance Verification Tests must be performed, beginning with "Visual Inspection" on page 2-12.

Test and Inspection Matrix

The matrix in Table 2-1 summarizes performance verification tests and inspections for the M3500B/M5500B; including test name, test or inspection to perform, expected test results, and data to record.

Table 2-1 Performance Verification and Safety Tests

Test Group Name	Test or Inspection to Perform	Expected Test Results	Data to Record P (pass) or F (fail)
Visual Inspection (VI)	Inspect unit, accessories, cables, etc. as described on page 2-12.	• If no unusual damage, no corrosion, no missing items, *then Visual Inspection passes*	*Example VI:p*
Functional Checks (F)	In normal Operating Mode, perform the following functional checks: • ECG (page 2-13). • Shock Advisory (page 2-14). • Synchronized Cardioversion (page 2-14). • SpO_2 (page 2-15).	• If all functions respond as expected: • Waveform clear on display; HR correct on display; HR alarm works. Leads off, pads off indicators as expected. • Shock Advised only when appropriate • Shock delivered with correct timing ($\leq$ 60msec) • 95% -100% *then Functional test passes*	*Example F:p*
Extended Self Test (X)	In Diagnostic Mode, run the Extended Self Test (page 2-17). Includes Data Card Test and time/date check.	If "Pass" reported on all tests applicable to the device configuration and options, *then Extended Self test passes*	*Example X:p*

Table 2-1 Performance Verification and Safety Tests *(Continued)*

Test Group Name	Test or Inspection to Perform	Expected Test Results	Data to Record P (pass) or F (fail)
User Interface Tests (U)	• In Diagnostic Mode, run the following tests (page 2-19): • Controls Test • Display Test • Audio Test • Printer Test	If all responses as expected: • All keys respond as expected • Display goes dark, then light. Black vertical bar scrolls across the screen from left to right. • Alerts, alarms, and tones are clearly heard • Print quality is adequate; no stray marks or lines • Print speed: 25 mm ± 5% (1.25mm) *then User Interface test passes*	*Example: U:p*
ECG Tests (E)	In Diagnostic Mode, run the ECG Tests (page 2-22): • Status messages (lead, pad, DSP) ***PCI measurement*** • PCI - Test Load attached • PCI - Pads open	If all data within limits, all checks pass: • "Good" displayed for all three status messages If all PCI measurements are within the following ranges: • 50 ± 30 Ω • ≥ 2000 Ω *then ECG test passes*	*Example:E:p*
Pacing Test (P)	In Diagnostic Mode, run the Pacing Test (page 2-25): • 200 mA	If measurement is within the following limit: • 200 mA± 20 mA *then Pacing test passes*	*Example: P:p*

Table 2-1 Performance Verification and Safety Tests *(Continued)*

Test Group Name	Test or Inspection to Perform	Expected Test Results	Data to Record P (pass) or F (fail)
Defibrillator Test - AC or DC Power Module (DM) (Required only when AC or DC power module used.)	Using only the AC or DC power module, enter Diagnostic Mode and run the Defibrillator Test (at 200Joules) (page 2-27): ***Displayed by M3500B/M5500B:*** • Available Energy after Shock • Msec to charge • Delivered energy • Impedance • Defib errors	If the measurements are as follows: • 0 • ≤ 15000 msec • Actual delivered energy 200 ±7% • 42 to 57 Ω • None (0) *then the Defibrillator test (Power Module) passes*	*Example: DM:p*
Defibrillator Test - Battery Power (DB)	Using only battery power, enter Diagnostic Mode and run the Defibrillator Test (at 200Joules) (page 2-28). ***Displayed by M3500B/M5500B*** • Available Energy after Shock • Msec to charge • Delivered energy • Impedance • Defib errors	If the measurements are as follows: • 0 • ≤ 3000 msec • Actual delivered energy 200 ±7% • 42 to 57 Ω • None (0) *then the Defibrillator test (Battery Power) passes*	*Example: DB:p*
Defibrillator Disarm Test (D)	Enter Diagnostic Mode and run the Defibrillator Disarm Test (page 2-29)	If all readings as expected Available energy - failure >0 No errors reported *then the Defibrillator Disarm test passes*	*Example: D:p*

Table 2-1 Performance Verification and Safety Tests *(Continued)*

Test Group Name	Test or Inspection to Perform	Expected Test Results	Data to Record P (pass) or F (fail)
Safety Tests	Indicate test results as follows:	Note: All Safety tests include both Normal and Reverse Polarity conditions.	
Earth Leakage Current (S1) (Required only when AC Power module is used.)	Earth Leakage Current NC (Normal Condition)	If NC maximum leakage current: ≤ 300 uA (UL), ≤500 uA and	*Example: S1:p/200/300*
	Earth Leakage SF (Single Fault - open neutral)	If SF maximum leakage current: ≤ 1000 uA *then S1 test passes*	
Patient Lead Leakage (S3) (Required only when AC Power module is used.)			S3:p/aa/bb/cc/dd/ee/ff/ggg/hhh/iii *Example: S3:p/9/49/49/10/50/50/100/499/750*
	ECG Patient Cable	If readings are as expected:	
	• Source (Normal Condition) - aa	• ≤ 10 uA	
	• Source (Single Fault Condition - open earth, open neutral) - bb	• ≤ 50 uA	
	• With Mains on applied part (Single Fault condition) - cc	• ≤ 50 uA *then Safety Patient Lead Leakage test passes*	
	SPO_2	If readings are as expected:	
	• Source (Normal Condition) - dd	• ≤ 10 uA	
	• Source (Single Fault Condition - open earth, open neutral) - ee	• ≤ 50 uA	
	With Mains on applied part (Single Fault condition) - ff	• ≤ 50 uA *then Safety Patient SPO2 Leakage test passes.*	

Table 2-1 Performance Verification and Safety Tests *(Continued)*

Test Group Name	Test or Inspection to Perform	Expected Test Results	Data to Record P (pass) or F (fail)
	Pads • Source (Normal Condition) - ggg • Source (Single Fault Condition) - hhh • With Mains on applied part (Single Fault condition) - iii	If readings are as expected: ≤ 100 uA ≤ 500 uA ≤ 5000 uA *then Safety Pads Test passes*	
Note: When recording test results, separate results within a test by slashes; separate tests by a semicolon (;); and do not use empty spaces. For example: VI:p;F:p;X:p;U:p;E:p;P:p;DM:p;DB:p;D:p;S1:p/200/300;S3:p/9/49/49/10/50/50/100/499/750			

Test Equipment

Table 2-2 lists the equipment needed to perform the Performance Verification tests, and provides specifications for commercially available analyzers and simulators. Test equipment is called out within each test procedure when needed. In addition, a digital voltmeter is also useful.

A 50 ohm test load is available from Philips Medical Systems (M1781A).

Table 2-2 Equipment List

Equipment/Test	Specifications
ECG Simulator	
Calibrated Leads ECG simulator	
• Amplitude accuracy	±2%
• Rate accuracy	±2%
Calibrated Paddles ECG simulator	
• Amplitude accuracy	±2%
• Rate accuracy	±2%
Defibrillator Analyzer	
Waveform compatibility	Meets all specs below using biphasic truncated exponential waveform.
Load resistance:	50 Ω ±1% (non-inductive)
Maximum energy:	≥ 200 joules
Maximum voltage:	≥ 2500 V
Maximum current:	≥50 A
Measurement accuracy:	
• ≥ 20 joules:	≤ ±2% of reading
• < 20 joules:	≤ ±0.4 joules
Cardioversion measurement range:	–150 to +150 ms

Table 2-2 Equipment List

Equipment/Test	Specifications
Pacer tester	
Load impedance:	≤400 Ω
Current measurement accuracy	
• 10 mA–50 mA:	<±2 mA
• 50 mA–200 mA:	<±4%
Rate measurement accuracy	
• 30–180 ppm:	<±0.5%
Waveform duration accuracy:	
• 30–180 ppm:	±1ms

Configuration and Diagnostic Modes

The instructions below describe how to enter Configuration Mode and Diagnostic Mode.

Configuration Mode

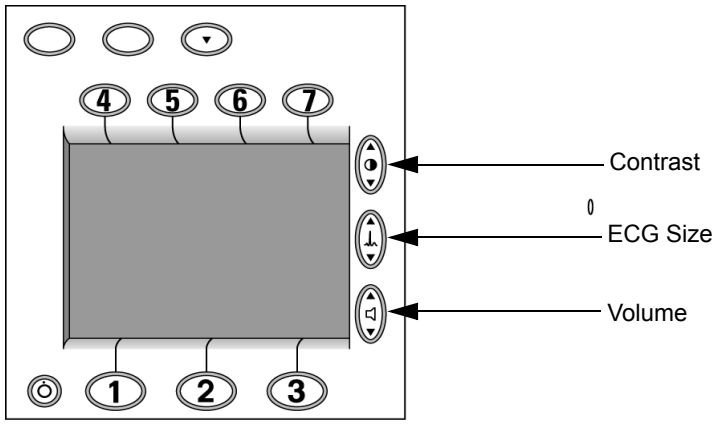
These instructions describe briefly how to enter Configuration Mode. See the ***Instructions for Use*** for details on configuration settings and what effect they have.

CAUTION

Inserting or removing the Data Card while the unit is on can corrupt the Data Card and prevent the unit from powering on again. If this occurs, see Chapter 3, Troubleshooting.

1. **Power off**.
   Make sure the unit's power is off.
2. **Insert the Data Card.**
   If you intend to save the configuration to a Data Card (or load the configuration from a Data Card), insert the Data Card now. To avoid possible confusion, designate one Data Card as the "Configuration Card" and label it clearly. Keep this card physically separate from cards used by the clinical staff for data storage.
3. **Enter Configuration Mode.**
   Press softkeys 4 and 5 at the same time, and hold them down while turning the power on. See Figure 2-1 for softkey numbering.
4. **Select and manage Configuration choices.**
   - To select a configuration, press the ▲ and ▼ softkeys to move up or down the list until the desired *Settings* item is highlighted. Then press the ENTER softkey to access those settings.
   - To print out a strip with all the current configuration choices, select *Print All Settings* and press ENTER.
   - To store the configuration settings on a data card, select *Save Settings to Data Card* and press ENTER. When prompted with *Save Settings to Data Card?* press SAVE.
   - To load configuration settings from a Data Card, select *Load Settings from Data Card* and press ENTER. When prompted with *Load Settings from Data Card?* press LOAD.
5. **Exit Configuration Mode.**
   - To exit Configuration Mode, turn the unit off.
   - Wait 2 seconds. Remove the Data Card by pressing the black eject button and pulling the Data Card from the compartment.

Figure 2-1 Softkey Numbers



Diagnostic Mode

These instructions describe how to enter Diagnostic Mode. Once in Diagnostic Mode, you can:

- Print the System Log (see "Printing the System Log" on page 3-6).
- Run the Extended Self Test (see "Diagnostic Tests" on page 2-16).
- Run other Diagnostic Tests (see "Diagnostic Tests" on page 2-16).

1. **Power off.**
   Make sure the power is off.
2. **Enter Diagnostic Mode.**
   Press softkeys 4 and 6 at the same time, and hold them down while turning the power on. See Figure 2-1.
3. **Wait for the Diagnostic software to initialize.**
   This will take several seconds. The unit is ready to proceed when the screen cursor responds to softkey inputs.
4. **Select the desired test or function.**
   - To select a test, press the ▲ and ▼ softkeys to move up or down the list until the desired test is highlighted. Then press the ENTER softkey to start that test.
5. **Exit Diagnostic Mode.**
   To exit Diagnostic Mode, turn the unit off.

Performance Verification

This section gives instructions for running Performance Verification tests on the M3500B/M5500B. The tests are sequenced to check more basic functions first, and then build on that to check more complex functions. We recommend you perform these tests in this sequence. If desired, you can make copies of the Test Results Matrix (page 2-3) and use it to record results.

The Performance Verification is divided into four sections:

Visual Inspection	Items that should be inspected each time the defib is serviced.
Functional Checks	A series of checks in normal operating mode to assess general performance.
Diagnostic Tests	A series of tests using the built-in Diagnostic Test menu. Describes how to access Diagnostic Mode, and how to run each of the Diagnostic Tests.
Safety Tests	Tests of safety related parameters such as leakage current.

Visual Inspection

1. Inspect the entire unit, especially power cords, printer, battery, cables, and sensors for signs of the following.

   - Wear or damage to patient cables and associated strain reliefs.
   - Mechanical damage to case, membrane switches, speaker cover, ambient light sensor cover, display window.
   - Loose or missing hardware.
   - Evidence of liquid spill. Check inside the printer bucket and clean out any accumulation using gloves and an approved cleaner.
   - Residue on the thermal printhead.
   - Printer roller wear.
   - Wear or damage to power cord and associated strain relief.
   - Corrosion on connector pins, printer parts, or battery contacts.

   Pass: Only normal wear, no damage serious enough to inhibit performance. No corrosion visible.

2. Check ECG electrodes and defibrillator pads for freshness (data code or expiration date) and condition.

   Pass: Electrodes and pads are within their expiration date and appear usable. Packaging is unopened and shows no tears or punctures. No corrosion visible on connector sockets, electrodes, or pads.

Functional Checks

The following functional checks exercise the basic functions of the defibrillator/monitor. They are intended as a broad check of the unit's performance, and are designed to complement (not replace) the Diagnostic Tests described later.

If all elements of a test pass, record that test as a PASS and return to the main diagnostic menu by pressing MAIN. If there is any failure, begin troubleshooting and repairing the unit as needed. See "Troubleshooting" on page 3-1.

ECG Functional Checks

This section describes how to check the operation of the ECG functions. Each of the ECG checks assumes the unit and the simulator are still set up as they were at the end of the previous ECG check.

To check ECG display and Heart Rate (HR) functions:

1. Connect the ECG simulator to both the Pads input and the 3- or 5-lead ECG cable. Set the simulator for normal sinus rhythm (NSR), 1mV amplitude, at some nominal rate (e.g., 60 bpm).
2. Set the M3500B/M5500B to Manual operating mode (not Diagnostic Mode).
3. Using the LEAD SELECT softkey, verify that the display shows a normal ECG with a clean baseline for both Pads and Lead II.
4. Verify the Heart Rate (HR) displayed is correct.
5. Disconnect the ECG simulator from the pads cable and verify that the display shows a dashed line in place of the waveform and that the unit both alarms and gives the *Pads Off* message.
6. If using a 5-lead ECG cable, set the defibrillator to monitor from the V lead.
7. Disconnect each of the ECG leads from the simulator one at a time, and verify that the display shows a dashed line in place of the waveform and that the unit both alarms and gives the *Leads Off* message.

To check ECG printing functions:

1. Reconnect the simulator.
2. Print a strip and verify that the strip shows a normal ECG with a clean baseline.
3. Verify that the date, time, and configuration information printed at the top of the strip is correct.

Shock Advisory Functional Check

This section describes how to check the Shock Advisory function.

1. Connect the ECG simulator to the pads cable. Set the simulator for normal sinus rhythm (NSR), 1mV amplitude, at some nominal rate (e.g., 60 bpm).
2. Set the M3500B/M5500B to AED Mode and press ANALYZE.
3. Verify that the defibrillator responds with *No Shock Advised*.
4. Set the simulator to Asystole (or turn the simulator off) and press ANALYZE. Verify that the defibrillator still responds with *No Shock Advised*.
5. Set the simulator to VF (Ventricular Fibrillation) and press ANALYZE. Verify that the defibrillator responds with *Shock Advised* and charges up to 150J. If the unit is configured to do so, verify that it automatically prints a strip of the event.

WARNING

Do not discharge the stored energy unless you are certain the simulator contains a 50 ohm test load.

6. If the simulator contains a 50 ohm test load, discharge the stored energy into the test load. If it does not, or you are not sure, wait until the defibrillator reports *Shock cancelled* before proceeding with other tests.

Synchronized Cardioversion Functional Check

This section describes how to check the operation of the synchronized cardioversion function.

1. Connect the ECG simulator to the ECG cable. Connect the defibrillator analyzer to the pads cable.
2. Set the simulator for normal sinus rhythm (NSR), 1mV amplitude, at some nominal rate (e.g., 60 bpm).
3. Set the defibrillator to Manual Mode, and press SYNC.
4. Verify that sync markers appear on the display, at the peak or on the falling side of the QRS complex. Adjust the size of the displayed ECG as needed to view it more clearly.
5. Select an energy of 5 J. Press CHARGE then press and hold SHOCK until the shock is delivered (at next QRS).
6. Verify on the defibrillator analyzer that the shock was delivered, and was 5J $\pm$2J.
7. If the unit is configured to do so, verify that it prints a strip with the correct information on it (waveform, text).
8. Verify on the defibrillator analyzer that the delay between the peak of the QRS and the delivered shock was $\leq$60 msec.

$Sp0_2$ Functional Check

This check only needs to be performed if SpO_2 is installed.

1. Attach the SpO_2 transducer to your finger.
2. Activate Manual Mode and press the SpO_2 softkey to turn SpO_2 on.
3. The SpO_2 value displayed should be in the range of 95-100%. If the value is less than 95%, check that your finger is fully inserted into the sensor and properly positioned.

Diagnostic Tests

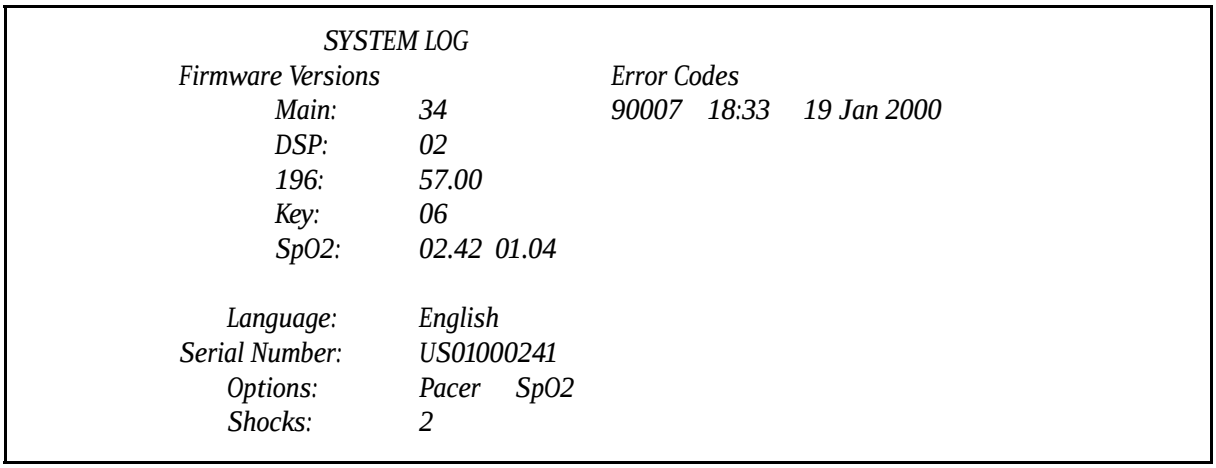
The M3500B/M5500B includes an extensive set of diagnostic tests, which test the major hardware components of the defibrillator.

The System Log

These instructions describe how to print the system log, which includes the unit's serial number, hardware configuration, and a listing of error codes. The System Log should be printed each time a Performance Verification Test is run.

1. Enter Diagnostic Mode as described in "Diagnostic Mode" on page 2-11.
2. Select *Print Log* and press ENTER.
3. The printer will print the System Log strip.
4. Check the printout to verify the printed results are consistent with the hardware in place. Check options installed (SpO_2, pacing) and the unit's serial number (on the bottom of the case). If the printout is not correct, investigate and resolve the source of the mismatch. Then reset the hardware options and serial number as needed using the Support Software Tool. See "The Language Support Tool" on page 4-67.
5. If there are errors reported in the System Log:
   a. Check the time and date stamps to see if they are recent errors or not. Consult Table 3-2 "Error Codes" on page 3-11 to identify the errors. Then begin troubleshooting as needed (see the "Troubleshooting" chapter.)
   b. Check that the time and date are correct. If they are not correct, access Configuration Mode and reset them.(If there are no errors, the time and date are not displayed.) See "Configuration Mode" on page 2-10.

Figure 2-2 Sample System Log Printout



SYSTEM LOG

Firmware Versions		*Error Codes*
Main:	*34*	*90007 18:33 19 Jan 2000*
DSP:	*02*	
196:	*57.00*	
Key:	*06*	
SpO2:	*02.42 01.04*	
Language:	*English*	
Serial Number:	*US01000241*	
Options:	*Pacer SpO2*	
Shocks:	*2*	

Extended Self Test

The Extended Self Test checks that all internal processors are operating and communicating with each other. The instructions below describe how to run the Extended Self Test.

If all results are as described, the unit passes this test. Return to the main Diagnostic Test menu by pressing MAIN.

If there is any failure, begin troubleshooting and repairing the unit as needed. See "Troubleshooting" on page 3-1, and Table 3-6 "Extended Self Test Failures" on page 3-18.

NOTE

Make sure that no one touches the unit during the self test as that can generate an erroneous *Not Tested* or *Fail* message.

1. Connect the test load to the pads cable.
2. Access the Diagnostic Test menu as described in "Diagnostic Mode" above.
3. Select *Extended Self Test* and press ENTER. The printout should appear similar to Figure 2-3.

Figure 2-3 Sample Extended Self Test Printout

EXTENDED SELF TEST		*18:48 1/19/2000*
ROM:	*Pass*	
RAM:	*Pass*	
System:	*Pass*	
Data Card:	*Not Tested*	
CODEC:	*Pass*	
IRDA:	*Not Tested*	
Timebase:	*Pass*	
Defib:	*Pass*	
FE:	*Pass*	
SpO2:	*Pass*	
Pacer:	*Pass*	

4. Check the printout to verify that the time and date are correct. If they are not, reset them using the Configuration Mode. See "Configuration Mode" on page 2-10.
5. The results of the following tests will appear on the display and on the printout:

   - *ROM*

     Tests the Read Only Memory (ROM).

   - *RAM*

     Tests the Random Access Memory (RAM).

- *SYSTEM*

  Tests the integrity of the core processing system and checks the Lithium backup battery.

- *Data Card*

  The Data Card test writes a small file to the data card, reads it back and checks it, then erases that file. If no Data Card is present, the test result will be *Not Tested*.

- *CODEC*

  The processor turns on the CODEC (coding/decoding) chip (used for voice prompts), and gets an acknowledgement that it's ready to receive data. It does not give the CODEC data to process.

- *IRDA*

  Tests the infrared communications port. If no active infrared device is within range, the test result will be *Not Tested*.

- *Timebase*

  The Timebase test compares the Real Time clock to the System clock to check for discrepancies. It does not test the SpO_2 clock or the Biphasic clock.

- *DEFIB*

  The Defib test charges the defibrillator capacitor and then disarms it. It does not deliver the energy outside the unit. The pads cable and test load must be connected for the test to run; otherwise the test result will be *Not Tested.*

- *FE*

  The Front End (FE) test checks that the main processor is communicating with the Digital Signal Processor (DSP), and that the DSP is communicating with both ECG front ends (pads and leads). It does not test the quality of the ECG measurement.

- *SP02* (if SpO_2 option installed)

  This tests that communication with the SpO_2 PCA is working. It does this by reading the software revision back from the PCA. It does not test the quality of the SpO_2 measurement.

- *Pacer* (if Pacing option installed)

  The Pacer test has the Pacer deliver current into the test box, and measures that the current delivered was what was expected. The pads cable and test load must be connected for the test to run; otherwise the test result will be *Not Tested.*

User Interface Tests

The User Interface Tests check the functions that provide information to the user, or receive inputs from the user. Each of the User Interface checks assumes the unit and the simulator are still set up as they were at the end of the previous User Interface check.

If all results are as described, the unit passes that test. Return to the main Diagnostic Test menu by pressing MAIN.

If there is any failure, begin troubleshooting and repairing the unit as needed. See "Troubleshooting" on page 3-1 and the following specific tables:

- Table 3-11 "Operational Problems - Printer" on page 3-25.
- Table 3-12 "Operational Problems - Display" on page 3-26.
- Table 3-13 "Operational Problems - Audio Tones/Voice Prompts" on page 3-27.
- Table 3-14 "Operational Problems - Keys" on page 3-28.

To check the Controls (keys):

1. Access the Diagnostic Test menu as described in "Diagnostic Mode" on page 2-11.
2. Select *Controls Test* and press ENTER. The screen will display a map of the front panel keys.
3. Press each of the numbered softkeys in turn. See Figure 2-1 on page 2-11 for numbering of softkeys. Each softkey number on the display should be highlighted each time that key is pressed. Don't press Softkey #4 MAIN at this time. This will return you to the Main diagnostic mode menu.
4. Check each of the *Contrast*, *ECG Size*, and *Volume* softkeys. See Figure 2-1 on page 2-11 for location of these keys.Each key should show a highlighted ⊞ ("plus") when the up arrow on the key is pressed, and show a highlighted ⊟ ("minus") when the down arrow is pressed.
5. Check each of the printer control keys (*Print Strip*, *Print Summary*, and *Mark Event*). Each corresponding softkey label on the display should be highlighted each time that key is pressed.
6. Check each of the Manual keys (under the Manual door). The displayed labels for *Manual*, *Sync*, *Pacer*, *Start/Stop* and *Mode* should be highlighted each time that key is pressed. The displayed labels for *Rate* and *Output* should show a highlighted ⊞ ("plus") when the up arrow on the key is pressed, and show a highlighted ⊟ ("minus") when the down arrow is pressed.

To check the display:

1. Select *Display Test* and press ENTER .
2. The display should turn completely dark, then completely light, then a black vertical bar should scroll across the screen from left to right.
3. The display should then show *Ambient Light Reading:* with a number. Under bright office lighting the reading would typically be about 10 or 15. Cover the ambient light sensor tightly with your finger; the reading should decrease (to near 0).
4. The display will also show softkey labels for BACKLIGHT ON and BACKLIGHT OFF. Press each key and verify that the backlight on the display cycles on and off.
5. The display will also show a TEST LEDs softkey label. Press this softkey and verify that the indicators in the Manual keypad each light in turn.

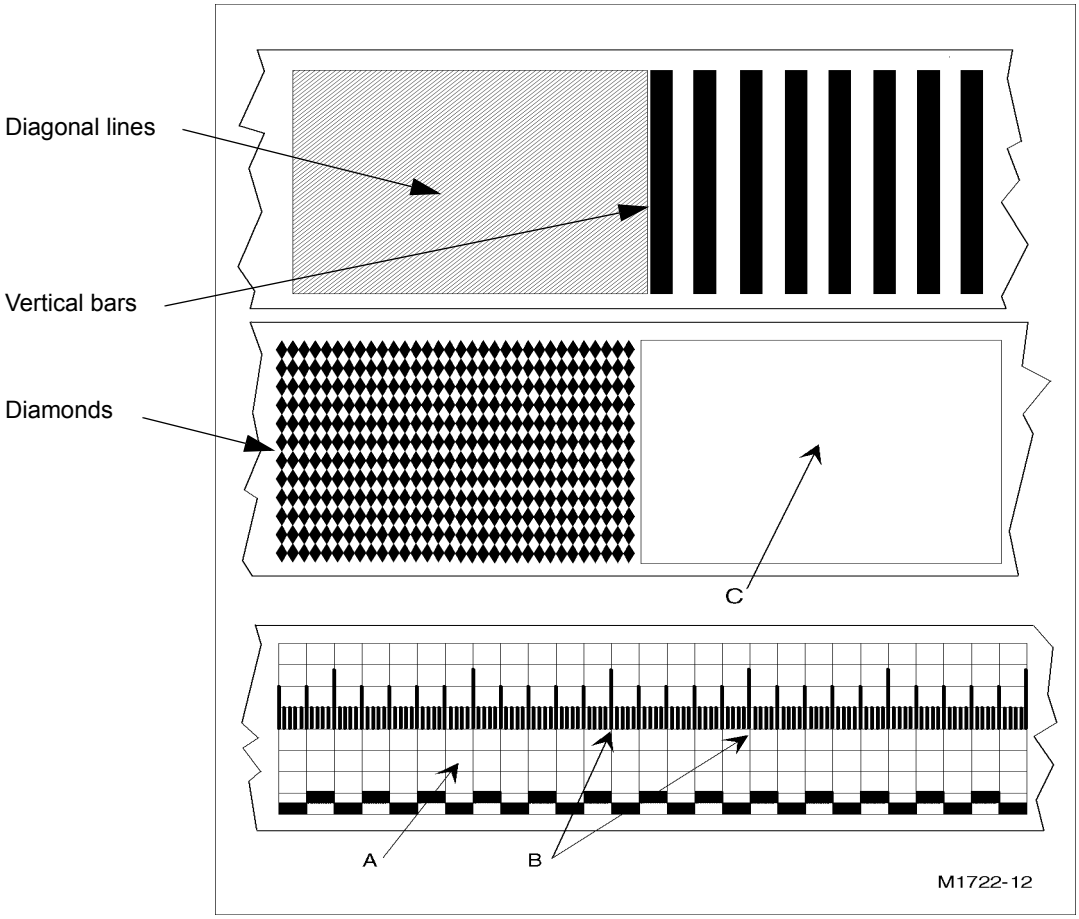
To check the audio output:

1. Select *Audio Test* and press ENTER .
2. The screen will display *Audio Test* menu. Press the ▲ and ▼ softkeys to move up or down the list to select the desired test. Then press ENTER to begin that test.
   Check the Shutdown Warning and the Voice Prompt; the other responses are for reference. The results should be as described below.
   Press CANCEL to end the test and return to the main audio test menu.
   - *Message Alert* - a repeating series of 3 short tones, followed by a pause.
   - *Heart Rate Alarm* - 1 sustained tone of moderately high pitch.
   - *Charge Done Tone* - 1 sustained tone of lower pitch than the Heart Rate Alarm
   - *Auto Disarm Warning* - a repeating series of 1 short tone and a pause
   - *Shutdown Warning* - a repeating series of tones of alternating high/low pitch
   - *Voice Prompt* - the prompt is repeated 3 times, each time with increasing volume. Voice should be clear and understandable.

To check the printer:

1. Select *Printer Test* and press ENTER. Press CANCEL to end the test and return to the main Diagnostic Test menu.
2. Verify that the test patterns on the strip are as indicated in Figure 2-4. Watch for white lines (printhead elements stuck off) or black lines (printhead elements stuck on). Check area "A" for stray marks or lines.
3. The area of Figure 2-4 labeled "C" contains printouts of all characters and symbols. Verify that they are readable.
4. Measure between the long tick marks (B in Figure 2-4) to verify paper speed. Distance should be 25mm ± 5% (±1.25 mm).
5. Open the printer door and press the **Print Strip** key. The unit should sound a series of 3 tones indicating a printer problem.
6. Take out the paper, close the door, and press the **Print Strip** key. The unit should sound a series of 3 tones indicating a printer problem.

Figure 2-4 Printer Test Output



ECG Tests

These instructions describe how to test the ECG functions.

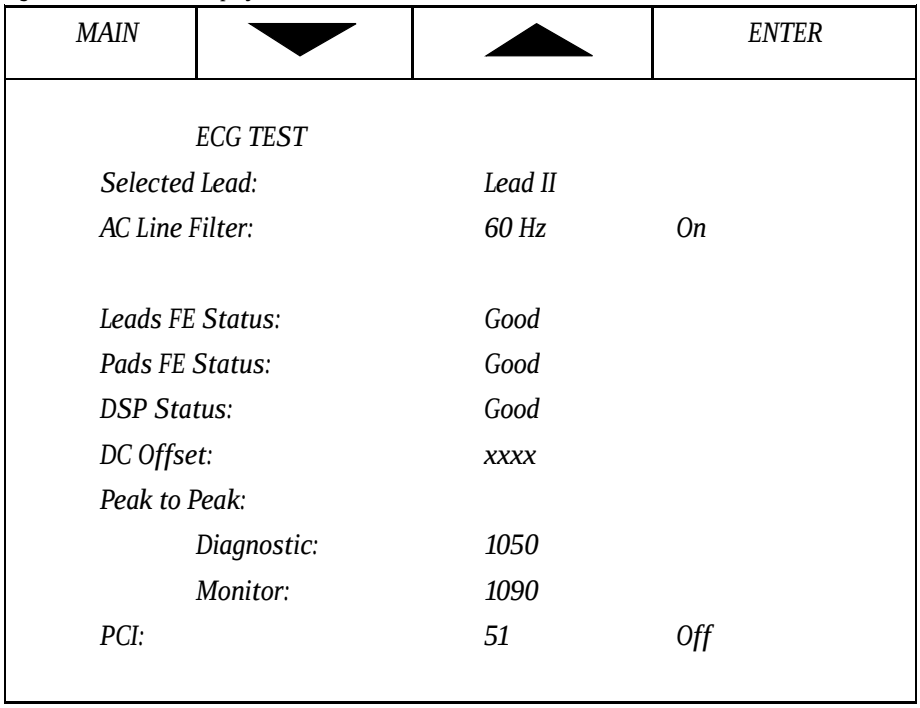
Each of the ECG tests assumes the unit and the simulator are still set up as they were at the end of the previous ECG test.

If all results are as described, the unit passes that portion of the test. Return to the main Diagnostic Test menu by pressing MAIN.

If there is any failure, begin troubleshooting and repairing the unit as needed. See "Troubleshooting" on page 3-1 and Table 3-7 "Operational Problems - ECG Monitoring (Pads or Leads)" on page 3-19.

1. Access the Diagnostic Test menu as described in "Diagnostic Mode" on page 2-11.
2. Select *ECG Test* and press ENTER.
3. The display should look similar to Figure 2-5:

Figure 2-5 ECG Test Display



Checking settings

In areas with 50 Hz power, the *AC Line Filter* should be set to *50 Hz*. If the setting is incorrect, access the Configuration Mode and correct it. See "Configuration Mode" on page 2-10.

The *PCI* setting should always be *Off* (factory set default). If it is *On*, press the Volume Up and Down arrow keys simultaneously to turn it *Off*. (See Figure 2-1 on page 2-11.) The software feature this setting controls is not used in the M3500B/M5500B.

Changing settings

To change the settings of *Selected lead* or *AC Line filter*, press the ▲ and ▼ softkeys to highlight the parameter, then press (and release) ENTER to select it. After a few seconds the highlighted selection will begin to blink, and the ▲ and ▼ softkeys will allow you change the selection to another of the values available. When the value you want is displayed, press ENTER to set that value. The available choices for Selected Lead will depend on whether the unit is configured for 3-lead or 5-lead ECG monitoring.

NOTE

These changes are only temporary, and will not override the configuration set by the user in the Configuration screens.

ECG Status messages

The 3 status messages (*Lead FE, Pad FE, DSP*) should all be *GOOD*.

- The *Leads FE* test checks that communication is working between the Leads Front End (FE) and the Digital Signal Processor (DSP).
- The *Pads FE* test checks that communication is working between the Pads FE and the DSP.
- The *DSP* test checks that communication is working between the DSP and the rest of the monitor.

DC Offset

This test is for manufacturer's use only and should be ignored.

ECG amplifier tests

These tests measure both the gain and the noise of the two ECG amplifiers (Leads and Pads). Both use the *Peak to Peak* reading.

The *Peak to Peak* reading measures the peak to peak amplitude of the signal appearing on the selected ECG input. If the simulator's calibrated output is 1.0 mV, then the *Peak to Peak* reading should be 1000 ± 10% (±100) for both *Monitor* and *Diagnostic*. If the simulator output is calibrated to some other value, the displayed value should be (1000 x simulator output) ±10%.

NOTE

The diagnostic frequency response is only available when using the ECG Leads input. When the unit is set to *Pads*, the display will indicate dashes (-----) for the *Diagnostic Peak-to Peak* value.

To test amplifier gain:

1. Connect the ECG simulator to the pads cable. Set the simulator output for sine wave, 2 Hz or 10 Hz, 1 mV peak-to-peak.
2. Following the instructions under "Changing settings" on page 2-23, set *Selected lead* to *Pads*. Only the *Monitor* frequency response will be available.
3. Wait for the displayed value under *Monitor* to stabilize.
4. The displayed value should be 1000 ±10% (±100). Record this as "aaaa".
5. Connect the ECG simulator to the ECG leads cable.
6. Following the instructions under "Changing settings", set *Selected lead* to *Lead II*.
7. Wait for the displayed value under *Diagnostic* to stabilize.
8. The displayed value should be 1000 ±10% (±100). Record this as "bbbb".

To test amplifier noise:

1. Turn the simulator off. Leave it connected to the ECG cable, and leave *Selected lead* set to *Lead II*.
2. Wait for the displayed value under *Diagnostic* to stabilize.
3. The displayed value should be 0 ± 30 uV. Record this as "cc".

   If the unit exhibits more than 30 uV of noise, try repositioning the cable or unit to minimize external interference. See "Reducing Electromagnetic Interference" on page 7-18. Also try various combinations of having the ECG simulator turned on or off, and (if applicable) whether the simulator is plugged into the AC mains.
4. Following the instructions under "Changing settings", set *Selected lead* to *Pads*.
5. Connect the simulator to the pads cable.
6. Wait for the displayed value under *Monitor* to stabilize.
7. The displayed value should be 0 ± 30 uV. Record this as "dd".

PCI function

This test checks the PCI (Patient Contact Impedance) function. The PCI measurement is used to detect *Pads Off*.

1. Connect the test load to the pads cable.
2. The PCI setting should always be *Off* (factory set default). If it is *On*, press the Volume Up and Down arrow keys simultaneously to turn it *Off*. (See Figure 2-1 on page 2-11.) The software feature this setting controls is not used in the M3500B/M5500B.
3. The PCI measurement should read 50 ohms ±30 ohms. Record this as "ee".
4. Disconnect the test load and leave the end of the cable open. The PCI measurement should read ≥ 2000 ohms (full scale). Record this as "ffff".

Pacing Test

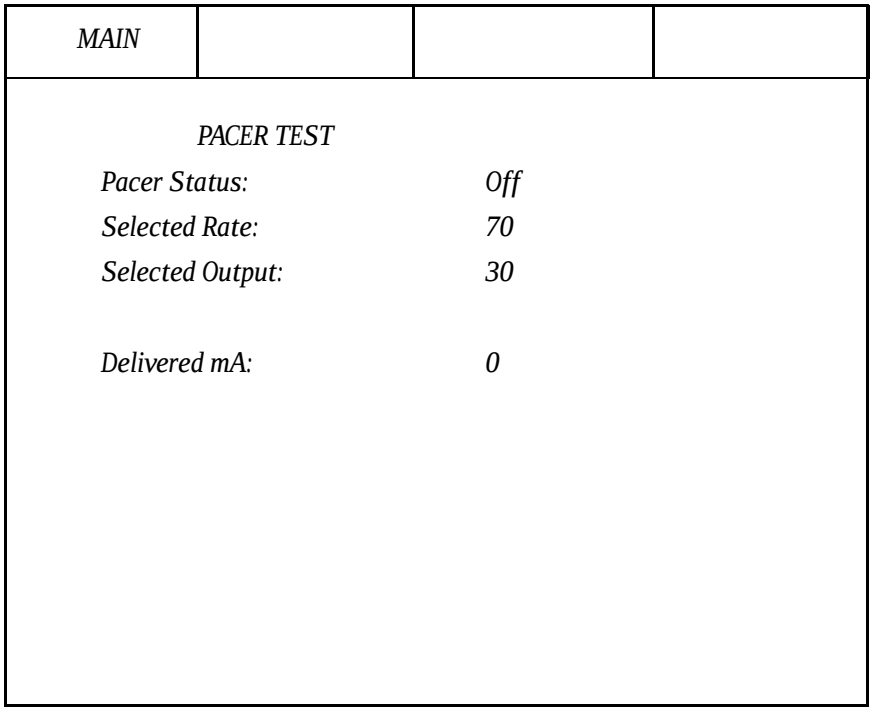
These instructions describe how to test the pacing function. This test only needs to be run if the Pacing option is installed.

If all results are as described, the unit passes the test. Return to the main Diagnostic Test menu by pressing MAIN.

If there is any failure, begin troubleshooting and repairing the unit as needed. See "Troubleshooting" on page 3-1 and Table 3-10 "Operational Problems - Pacing" on page 3-24.

1. Connect the defibrillator to the Pacer tester.
2. From the Diagnostic Menu, select *Pacer Test* and press ENTER. The display should look similar to Figure 2-6.

Figure 2-6 Pacer Test Display



3. Press Pacer. The LED to the left of the button will illuminate. The screen display of *Pacer Status* will change to *Stopped.*
4. Press Start Stop. *Pacer Status* will change to *Pacing*, and pacing will begin at the default settings of 70 beats per minute (bpm) and 30 mA.
5. The Pacer should be delivering a current of 30mA ±5mA. Record the delivered current indicated by the Pacer tester as "aa".
6. The display on the M3500B/M5500B should read the delivered current as measured by the Pacer tester ("aa") ±5 mA.

7. Using the

button, increase the rate to 180 bpm.
8. Using the

button, increase the output to 200 mA.
9. The Pacer should be delivering a current of 200mA ±20mA. Record the delivered current indicated by the Pacer tester as "bbb".
10. The display on the M3500B/M5500B should read the delivered current as measured by the Pacer tester ("bb") ±20 mA.
11. Turn off Pacing by pressing the

button.

Defibrillator Test (AC Power At 200 J)

These instructions describe how to test the defibrillation function when powered only by the AC Power Module (no battery installed).

This test is required only if the defibrillator is connected to AC power during normal use.

If all results are as described, the unit passes the test. Return to the main Diagnostic Test menu by pressing MAIN.

If there is any failure, begin troubleshooting and repairing the unit as needed. See "Troubleshooting" on page 3-1 and Table 3-9 "Operational Problems - Defibrillation and Synchronized Cardioversion" on page 3-22.

1. Turn defibrillator off and remove the battery. Connect the AC Power Module.
2. Connect the defibrillator analyzer to the pads cable. Set the analyzer to measure delivered energy. If needed, reset the analyzer's display to read 0.
3. Turn the defibrillator on, and from the Diagnostic Menu, Select the *Defib Meas Test* and press ENTER.
4. Use the ENERGY SELECT softkey to select 200J. Then press the CHARGE softkey to charge the defibrillator. Press SHOCK.

Readings from defibrillator analyzer:

Read the delivered energy indicated by the defibrillator analyzer. It should be 200J ±15% (±30J). Record as "aaa".

Readings from M3500B/M5500B display:

The results displayed by the M3500B/M5500B should be as follows:

Available Energy:	*Not recorded - failure if > 0.*	
ms to Charge:	*≤ 15000*	*(Record as "bbbbb")*
Delivered Energy:	*Actual delivered energy ("aaa") ±7%*	*(Record as "ccc")*
Impedance:	*42 to 57 ohms*	*(Record as "dd")*
Peak Current:	*Ignore. Derived from same measurements as delivered energy and impedance*	
Defib Errors:	*Not recorded - failure if any reported.*	

Defibrillator Test (Battery Power At 200 J)

These instructions describe how to test the defibrillation function when powered only by a fully charged battery, with no AC Power Module connected.

This test is always required when performing the full Performance Verification test.

If all results are as described, the unit passes the test. Return to the main Diagnostic Test menu by pressing MAIN. If there is any failure, begin troubleshooting and repairing the unit as needed. See "Troubleshooting" on page 3-1 and Table 3-9 "Operational Problems - Defibrillation and Synchronized Cardioversion" on page 3-22.

1. Turn defibrillator off. Insert the battery and disconnect the AC Power Module.
2. Connect the defibrillator analyzer to the pads cable. Set the analyzer to measure delivered energy. If needed, reset the analyzer's display to read 0.
3. Turn the defibrillator on, and from the Diagnostic Menu, Select the *Defib Meas Test* and press ENTER.
4. Use the ENERGY SELECT softkey to select 200J. Then press the CHARGE softkey to charge the defibrillator. Press SHOCK.

Readings from defibrillator analyzer:

Read the delivered energy indicated by the defibrillator analyzer. It should be 200J ±15% (±30J). Record as "aaa".

Readings from M3500B/M5500B display:

The results displayed by the M3500B/M5500B should be as follows:

Available Energy:	*Not recorded - failure if > 0.*
ms to Charge:	*≤3000 (Record as "bbbb")*
Delivered Energy:	*Actual delivered energy ("aaa") ±7%(Record as "ccc")*
Impedance:	*42 to 57 ohms (Record as "dd")*
Peak Current:	*Ignore. Derived from same measurements as delivered energy and impedance*
Defib Errors:	*Not recorded - failure if any reported.*

NOTE

If the "*ms to Charge*" measurement is too high (unit takes too long to charge), verify that the battery is fully charged. If it is, the battery may simply be old. The 3000 ms specification is defined for a new, freshly charged M3516A/M5516A. Replace the battery with one that is new and fully charged, and repeat the test.

Defibrillator Disarm Test

These instructions describe how to test the disarm function.

If all results are as described, the unit passes the test. Return to the main Diagnostic Test menu by pressing MAIN. If there is any failure, begin troubleshooting and repairing the unit as needed. See "Troubleshooting" on page 3-1.

1. Connect the defibrillator analyzer to the pads cable. If needed, reset the analyzer's display to read 0.
2. From the Diagnostic Menu, Select the *Defib Meas Test* and press ENTER.
3. Use the ENERGY SELECT softkey to select 200J. Then press the CHARGE softkey to charge the defibrillator. Press DISARM.

Readings from defibrillator analyzer:

Read the delivered energy indicated by the defibrillator analyzer. It should be 0J or be blank.

Readings from M3500B/M5500B display:

The results displayed by the M3500B/M5500B should be as follows:

Available Energy	*Not recorded - failure if > 0.*
Msec to charge	*Ignore - tested earlier*
Delivered energy	*Blank*
Impedance	*Blank*
Peak current	*Blank*
Defib errors	*Not recorded - failure if any reported.*

Safety Tests

This section covers tests of the defibrillator's electrical safety.

These safety tests only need to be performed if the customer normally uses the defibrillator with the AC Power Module connected. If the defibrillator is normally used on battery power only, these tests do not need to be performed.

Using the procedures called out by the manufacturer of the analyzer in use, measure and record the following data. Only test at the AC Mains (line) voltage used in the customer's facility - there is no need to test both 120VAC and 240VAC. Also, test both Normal and Reverse Polarity line connections, and record the worst case value.

Earth Leakage

- Normal Condition - ≤ 500 uA (≤ 300 uA for UL)

  Record as "aaa".

- Single Fault Condition - ≤ 1000 uA

  Record as "bbbb".

Patient Lead Leakage

Test both Leads (C) and pads (B) inputs.

- Source (Normal Condition) - ≤ 10 uA (C), ≤ 100 uA (B)

  Record as "ccc".

- Source (Single Fault Condition) - ≤ 50 uA (C), ≤ 500 uA (B)

  Record as "ddd".

- With Mains on Applied Part (Single Fault Condition) - ≤ 50 uA (C), ≤ 5000 uA (B)

  Record as "eeee".

- Auxiliary (Normal Condition) - ≤ 10 uA (C), ≤ 100 uA (B)

  Record as "fff".

- Auxiliary (Single Fault Condition) - ≤ 50 uA (C), ≤ 500 uA (B)

  Record as "ggg".

Battery Capacity Test

The Battery Capacity Test is ***not*** part of the routine Performance Verification. This test is part of the routine checks that the user performs. See the ***Instructions for Use*** for details. It is included here for reference.

To perform a Battery Capacity Test:

1. Turn the M3500B/M5500B off.
2. Place a "Test in Progress" label on the unit to indicate to others that it may not be used.
3. Insert a charged battery.
4. If an AC or DC power module is connected, unplug the power module from the HeartStart XLT. While pressing Mark Event, press **On** to start the test.
5. Allow the test to proceed to completion. The test takes approximately three hours and is complete when test results print out and the device turns itself off.
6. Review the test results and take the appropriate action, as follows:

Table 2-3 Battery Capacity Test Results

If	Then
Elapsed Time ≥ 2.5 hours and Low Battery Time ≥ 10 minutes	1. The battery passed the test. 2. Record "pass CT" and the date on the label on the bottom of the battery. 3. Recharge the battery before use.
Elapsed Time < 2.5 hours or Low Battery Time < 10 minutes	1. The battery failed the test. 2. Record "fail CT" and the date on the label on the bottom of the battery. 3. Discard the battery appropriately.

NOTE

If the message "Unsupported Battery" appears, replace the battery with the M3516A battery. See Table 3-15 on page 3-29.

3 Troubleshooting

Overview

This chapter provides information for troubleshooting problems with the M3500B/M5500B. The "Troubleshooting and Repair Methodology" section of this chapter (page 3-2) provides an overview of the steps needed to isolate and repair unit problems.

Repair Philosophy

The repair philosophy of the M3500B/M5500B is subassembly replacement. Examples of subassemblies are the printer, the Control PCA, and selected connectors and other items. Repairs that involve replacing components on a PCA are ***not*** supported.

CAUTION

Individual component replacement should ***not*** be attempted outside of a factory authorized repair facility. Component level repair is extremely difficult due to the extensive use of surface mount technology and the high parts-density on the circuit boards. Unauthorized component replacement can impair performance of the M3500B/M5500B.

Equipment Required

Troubleshooting requires the same test equipment as does Performance Verification. See "Test Equipment" on page 2-8.

Troubleshooting and Repair Methodology

The M3500B/M5500B is designed to be a sealed, water resistant unit. We recommend you follow the steps below so the sealing surfaces are not disturbed unless absolutely necessary:

Interview the User

If possible, talk directly with the user who reported the problem. Identify what they were doing when the problem occurred, and exactly what happened. What was on the display? What tones or voice prompts were heard? Were there operational problems?

Identify the Problem

First, evaluate the unit's condition using the steps in "Initial Assessment" on page 3-3. Then use "Diagnosing External Failures" on page 3-4 to identify problems that can be resolved without further troubleshooting. Finally, if needed use "Diagnosing Internal Failures" on page 3-5 to isolate the problem to a particular subassembly.

If no trouble is found, proceed to the "Performance Verification and Safety Tests" chapter for instructions on tests to run.

Perform the Repair

Follow the procedures in the "Removal and Replacement" chapter to replace any defective subassemblies.

When the repair is complete, it is good practice to check the repair by attempting to reproduce the specific problem found. It is also advisable to print the System Log again to check that no errors have been logged after the repair.

Test the Unit

Use the procedures found in the "Performance Verification and Safety Tests" chapter to verify that the unit is operating properly overall. Be sure the testing performed is appropriate for the level of repair.

Initial Assessment

Use the following steps to isolate the problem to a particular subassembly.

Attempt Power Up

Assess the unit's condition by performing the following steps.

1. Disconnect the Power Module (if connected).
2. Insert a fully charged battery into the unit.
3. If the unit is used with a Data Card, insert a new, empty M3510A/ M5510A Data Card into the unit.
4. Attempt to power up the unit by pressing *On*.

Evaluate the Response

The unit will respond in one of the following 3 ways:

No response

IF The unit emits no sounds, and no changes are visible on the display.

THEN Troubleshoot further using Table 3-1 on page 3-9. ("Unit Unresponsive").

Minimal response

IF Unit provides only a slight response, such as a click or chirp from the speaker, or a change in the contrast or the borders of the display.

THEN Replace the Control PCA (see "Removal and Replacement" on page 4-1).

Return to this section and begin again with "Attempt Power Up".

Powers Up

IF The unit powers up to one of the following states:

a. It can generate tones or voice prompts, or display text or graphics, or respond to keypresses.

b. The screen is blank except for an error message such as *Defib Failure - Cycle Power*.

THEN Proceed to "Diagnosing External Failures" on page 3-4.

Diagnosing External Failures

Many times, a problem will be the result of external failures such as defective cables, depleted batteries, or improper operation. Use the steps below to rule out these external failures before looking for an internal failure in the unit.

Capture the Configuration Data

Store the unit's configuration data on a Data Card or print out the current configuration, if possible. See "Accessing Configuration Mode" on page 3-5.

Print the System Log

Print out the System Log if possible, and use any error codes to help isolate the problem. See "Printing the System Log" on page 3-6.

NOTE

The M3500B/M5500B log of error codes only reports the last 10 errors. If new errors are created at this stage they may overwrite the existing codes and valuable clues to the reported problem might be lost.

Rule out external components and improper use

Referring to Table for Supplies and Accessories, make sure the unit has:

- An undamaged, fully charged M3516A/M5516A battery.
- A new, dry roll of Philips 40457C/D printer paper. Printer paper may jam if paper is wet. Also, printer may be damaged if wet paper is allowed to dry while in contact with printer elements.
- Cables and sensors which are approved by Philips and known to be good. Also make sure that all external cables are fully inserted in their receptacles.
- A new, empty Data Card of the correct type (M3510A/M5510A). Plugging in the wrong type of card (e.g., a modem card) can cause startup failures.

To help identify problems which may be caused by external components or by improper use, refer to:

- Table 3-3 ("System Messages") and Table 3-4 ("Momentary Messages"). While both sets of messages are intended for the end user and are found in the ***Instructions for Use***, they are included here for reference.
- The individual tables describing Operational Problems associated with each function (defibrillation, ECG, etc.). The Operational Problems tables describe failures to operate properly and indicate what corrective actions the service person should take.

Diagnosing Internal Failures

The following steps will help you isolate an internal failure to a particular subassembly.

Run Self Tests

To run the Self Tests, perform the following steps:

1. Enter Diagnostic Mode. See "Accessing Diagnostic Mode" on page 3-6.
2. Run the Extended Self Test. See "Extended Self Test" on page 2-17.
3. Run the individual Diagnostic Tests that are applicable to the problem. Diagnostic Tests are described starting with "User Interface Tests" on page 2-19.

Use the Troubleshooting Tables

Use the Tables provided starting on page 3-8 to isolate the problem based on factors such as:

- Error codes reported in the System Log (Table 3-2, page 3-11).
- Extended Self Test failures (Table 3-6, page 3-18).
- Operational problems (starting with Table 3-7 on page 3-19).

Configuration and Diagnostic Modes

Some of the Troubleshooting procedures look for responses from the unit that are dependent on that unit's configuration. Similarly, many procedures require that the unit be in Diagnostic Mode. Follow the instructions given below to enter these modes.

Accessing Configuration Mode

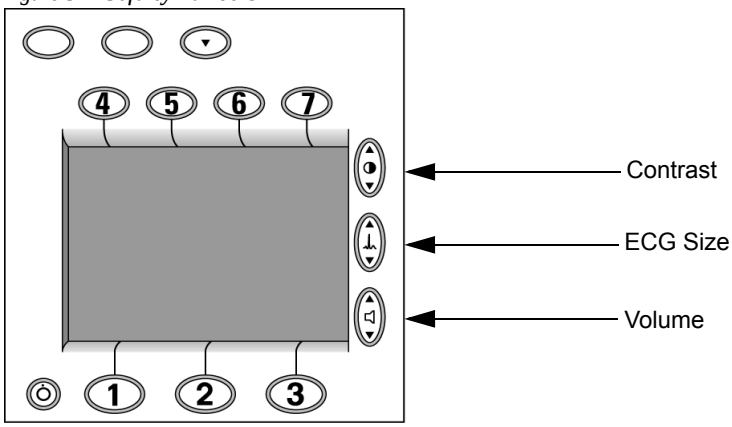
These instructions describe briefly how to enter Configuration Mode. See the ***Instructions for Use*** for details on configuration settings and what effect they have.

1. Make sure the power is off.
2. If you intend to save the configuration to a Data Card (or load the configuration from a Data Card), insert the Data Card now.
3. Press softkeys 4 and 5 at the same time, and hold them down while turning the power on. See Figure 3-1 for softkey numbering.

   - To select a configuration, press the ▲ and ▼ softkeys to move up or down the list until the desired *Settings* item is highlighted. Then press the ENTER softkey to access those settings.
   - To print out a strip with all the current configuration choices, select *Print All Settings* and press ENTER.

- To store the configuration settings on a data card, select *Save Settings to Data Card* and press ENTER. When prompted with *Save Settings to Data Card?* press SAVE.
- To load configuration settings from a Data Card, select *Load Settings from Data Card* and press ENTER. When prompted with *Load Settings from Data Card?* press LOAD.
- To exit Configuration Mode, turn the unit off. Wait 2 seconds. Remove the Data Card by pressing the black eject button and pulling the Data Card from the compartment.

Figure 3-1 Softkey Numbers



Accessing Diagnostic Mode

These instructions describe how to enter Diagnostic Mode. The Diagnostic Mode allows printing of the System Log (see "Printing the System Log" on page 3-6). It also allows running the Extended Self Test and other Diagnostic Tests. For details of running these tests, see "Diagnostic Tests" on page 2-16.

1. Make sure the power is off.
2. Press softkeys 4 and 6 at the same time, and hold them down while turning the power on. See Figure 3-1 for softkey numbering.
3. **Wait for the Diagnostic software to initialize. This will take several seconds. The unit is ready to proceed when the screen cursor responds to softkey inputs.**

   - To select a function, press the ▲ and ▼ softkeys to move up or down the list until the desired function is highlighted. Then press the ENTER softkey to begin that function.
   - To exit Diagnostic Mode, turn the instrument off.

Printing the System Log

These instructions describe how to print the system log, which includes the unit's serial number, hardware configuration, and a listing of error codes.

1. Enter Diagnostic Mode as described in "Accessing Diagnostic Mode".

2. Select *Print Log* and press ENTER.
3. The printer will print the System Log strip. See Figure 3-2.
4. Check the printout to verify the printed results are consistent with the hardware in place. Verify options installed (SpO2, pacing) and the unit's serial number (on the bottom of the case). If the printout is not correct, investigate and resolve the source of the mismatch. Then reset the hardware options and serial number as needed using the Support Software Tool. See "The Language Support Tool" on page 4-67.
5. If there are errors reported in the System Log:
   a. Check the time and date stamps to see if they are recent errors or not. Consult Table 3-2 "Error Codes" on page 3-11 to identify the errors. Then begin troubleshooting as needed (see the "Troubleshooting" chapter.)
   b. Check that the time and date are correct. If they are not correct, access Configuration Mode and reset them. See "Accessing Configuration Mode" on page 3-5.

Figure 3-2 Sample System Log Printout

SYSTEM LOG

Firmware Versions		*Error Codes*
Main:	*34*	*90007 18:33 19 Jan 2000*
DSP:	*02*	
196:	*57.00*	
Key:	*06*	
SpO2:	*02.42 01.04*	
Language:	*English*	
Serial Number:	*US0100241*	
Options:	*Pacer SpO2*	
Shocks:	*2*	

Troubleshooting Tables

Below are the troubleshooting tables provided.

Table 3-1	"Unit Unresponsive"
Table 3-2	"Error Codes"
Table 3-3	"System Messages"
Table 3-4	"Momentary Messages"
Table 3-5	"Audio Tones"
Table 3-6	"Extended Self Test Failures"
Table 3-7	"Operational Problems - ECG Monitoring (Pads or Leads)"
Table 3-8	"Operational Problems - SpO_2 Monitoring"
Table 3-9	"Operational Problems - Defibrillation and Synchronized Cardioversion"
Table 3-10	"Operational Problems - Pacing"
Table 3-11	"Operational Problems - Printer"
Table 3-12	"Operational Problems - Display"
Table 3-13	"Operational Problems - Audio Tones/Voice Prompts"
Table 3-14	"Operational Problems - Keys"
Table 3-15	"Operational Problems - Battery, AC or DC Power Modules, Battery Charger Adapter"
Table 3-16	"Power Module Indicator Matrix"
Table 3-17	"Operational Problems -Data Card"

Using the Tables

The tables will often suggest more than one **cause** for a symptom, and more than one **solution** for each cause.

The **causes** are arranged in order of the approximate probability of their occurrence. Investigate the causes proposed in the order given. If one cause turns out not to be the problem, try the next.

For each cause there may also be multiple **solutions** given. These are arranged in the recommended order of their implementation. Try the first solution, and if that does not fix the problem, try the next.

Before replacing any parts, check to see if the cables and flex circuits are properly connected. See "Servicing Notes" on page 4-1.

Unit Unresponsive

Isolate the fault by following the steps in Table 3-1. Before replacing any parts, check to see if the cables and flex circuits are properly connected. See "Servicing Notes" on page 4-1.

Table 3-1 Unit Unresponsive

Test	Result	Possible Causes	Corrective Actions
1. Connect Power Module to power source ONLY (AC Mains or DC) and observe indicators on Power Module (see Figure 3-3 on page 3-30).	"Power' indicator turns RED.	Power Source voltage low.	Check/correct source voltage.
		Failure in Power Module.	Replace Power Module.
	'Power' indicator turns GREEN.		Proceed to step 2.
2. Connect Power Module to unit.	"Power' indicator turns RED.	Short in unit's 12 volt wiring.	1. Check/replace Battery PCA 2. Check/replace wiring to Power PCA
		Short on Power PCA.	Replace Power PCA.
		Short on Control PCA.	Replace Control PCA.
	'Power' indicator stays GREEN.		Proceed to step 3.
3. Attempt to power up unit.	"Power' indicator turns RED.	Failure on Power PCA.	Replace Power PCA.
		Failure on Control PCA.	Replace Control PCA.
	'Power' indicator stays GREEN.		Proceed to step 4.

Table 3-1 Unit Unresponsive *(Continued)*

Test	Result	Possible Causes	Corrective Actions
4. Observe unit's response.	Unit powers up to some working state.	Main fuse open.	1. Replace Main Fuse 2. Replace Power PCA and Main Fuse.
		Open in battery wiring.	1. Check/replace Battery PCA 2. Check/replace wiring to Power PCA
	Unit still unresponsive.	Short or other failure somewhere in unit.	Disconnect printer and display from Control PCA at Control PCA. Then proceed to step 5.
5. Attempt to power up unit.	Unit powers up to some working state.	Short in printer or display.	Isolate the fault by reconnecting one at a time and powering up again. Then replace the display or printer as needed.
	Unit still unresponsive.	Short or other failure somewhere in unit.	1. Replace Control PCA. 2. Replace Power PCA. 3. Replace Interface PCA. If all above unsuccessful, return unit for bench repair.

Error Codes

The System Log provides error codes in 5 digit hexadecimal format. Before replacing any parts, check to see if the cables and flex circuits are properly connected. See "Servicing Notes" on page 4-1.

NOTE

Confirm any errors by running the self-tests again, making sure that no one touches the unit during the test.

Table 3-2 Error Codes

Error Code	Meaning	Possible Solutions
00000 - 00400	Defib failure - charging circuits.	1. Replace Power PCA. 2. Replace Control PCA.
01000	Defib failure - biphasic processor.	1. Replace Power PCA. 2. Replace Control PCA.
02000	Leads front end failure.	1. Replace Interface PCA. 2. Replace Control PCA.
04000	Pacer failure.	Replace Power PCA.
08000	Processor error.	Replace Control PCA.
10000 - 1FFFF	System monitor failure.	1. Cycle power. 2. Replace Control PCA.
10001	Processor Synchronization Error	Cycle power.
10004	Synchronization Time Out	Cycle power. • If error does not repeat, run ALL Performance Verification Tests. If unit passes all tests, the unit can be returned to service. • If error repeats, replace Control PCA.
20000 - 2FFFF	Front end failure.	1. Replace Control PCA. 2. Replace Interface PCA.
30000 - 3FFFF	Pacer failure.	1. Replace Power PCA. 2. Replace Control PCA.
40000 - 4FFFF	Monitor processor failure.	1. Replace Control PCA. 2. Replace Interface PCA.
50000 - 5FFFF	SpO_2 problem.	1. Replace SpO2 PCA. 2. Replace Interface PCA. 3. Replace Control PCA.
60000 - 6FFFF	Advisory Failure.	Replace Control PCA.

Table 3-2 Error Codes *(Continued)*

Error Code	Meaning	Possible Solutions
80000 - 8FFFF	IRDA failure.	1. Replace Interface PCA. 2. Replace Control PCA.
90000 - 90002	Self Test failure - RAM/ROM or Gate Array.	1. Replace lithium battery. 2. Replace Control PCA.
90003	Self Test failure - Data Card circuits.	Replace Control PCA.
90004 and 90005	Self Test failure - Codec/time base.	1. Replace lithium battery. 2. Replace Control PCA.
90006	Self Test failure - SpO_2.	1. Replace SpO2 PCA. 2. Replace Control PCA. 3. Replace Interface PCA.
90007 and 90008	Self Test failure - Pacer or Defib.This error can be caused by pressing the Pacer key during the self-test.	1. Run the self-test again, making sure not to touch the unit during the test. 2. Replace Power PCA. 3. Replace Control PCA.
90009	Self Test failure - Front End.	1. Replace Power PCA. 2. Replace Control PCA. 3. Replace Interface PCA.
9000A	Lithium backup battery failure.	1. Replace lithium battery. 2. Replace Control PCA.
A0000-A7FFF	Data Card failure.	1. Replace Data Card. 2. Replace Control PCA.
A8000 - AFFFF	Data Archival error.	1. Replace Data Card. 2. Replace Control PCA.
B0000 - BFFFF	Audio failure.	Replace Control PCA.
F0000 - FFFFF	RAM/ROM failure.	Replace Control PCA.
F0002	Promo Mode failure.	Replace Control PCA.
F0003	Keyscanner failure.	1. Replace Keyscan PCA. 2. Replace Control PCA.
F0004	System Communication error.	Replace Control PCA.
F0007	System Communication error	Cycle power.

System Messages

System messages remain on the display until the specified action is taken or no longer relevant. They are intended for the end user and appear in the ***Instructions for Use***. They are duplicated here for the reference of the service person.

Before replacing any parts, check to see if the cables and flex circuits are properly connected. See "Servicing Notes" on page 4-1.

Table 3-3 System Messages

Message	Description	Corrective Action
Attach Pads Cable	The pads cable is not properly attached to the device.	Check the cable connection
Configuration Lost	The configuration is reset to the default settings.	1. Reconfigure the M3500B/M5500B. 2. If problem reoccurs, service the unit. See "Troubleshooting" on page 3-1 and Table 3-6 on page 3-18.
Data Card Disabled	The PC card is not in use because it is full, incompatible, absent, or inserted after the M3500B/M5500B was turned on.	If possible, turn the M3500B/M5500B off for more than 2 minutes, then insert a new, empty, M3510A/M5510A Data Card and turn the device on.
ECG Fault	The ECG data acquisition system failed and data is unavailable from the 3- or 5-lead monitoring electrodes.	Service the unit. See "Troubleshooting" on page 3-1 and Table 3-7 on page 3-19.
Monitor Failure - Cycle Power	An error has occurred in the monitoring subsystem.	Turn power off, then on. If message reappears, service the unit. See "Troubleshooting" on page 3-1.
Low Battery	The battery has sufficient capacity remaining to provide only about ten minutes of monitoring time and six shocks before the M3500B/M5500B shuts off.	Replace the battery with a fully charged M3516A/M5516A battery.
Leads Off	The monitoring electrodes are not applied or are not making proper contact with the patient. The ECG cable is not connected. The internal cable from the ECG connector to the Interface PCA is disconnected Failure on the Interface PCA.	Check that the monitoring electrodes are properly applied. Check that the ECG cable is properly connected. Check the internal cable. Replace the Interface PCA.
No Pads	The multifunction defibrillation electrode pads are not properly connected to the M3500B/M5500B.	Check the pads cable connection.

Table 3-3 System Messages *(Continued)*

Message	Description	Corrective Action
Pads Cable Off	The pads cable is not connected to the defibrillator. Failure on Power PCA.	Check that the pads cable connector is locked in place. Replace Power PCA.
Pads Off	The pads are not making proper contact with the patient. Failure on Power PCA.	Make sure the pads are properly applied to the patient. Replace Power PCA.
Defib Failure - Cycle Power	An error has occurred in the defibrillator subsystem.	Turn power off, then on. If message reappears, service the unit. See "Troubleshooting" on page 3-1 and Table 3-9 on page 3-18.
Pacer Failure	The pacing system is not functioning.	Service the unit. See "Troubleshooting" on page 3-1 and Table 3-10 on page 3-24.
Pacer Output Low	High patient impedance is resulting in the pacer delivering less current to the patient than specified in the output current setting.	Check the pads are applied properly.
System Failure Service Unit	A serious malfunction has occurred.	Service the unit. See "Troubleshooting" on page 3-1.
SpO2 Cable Off	The SpO_2 cable is not connected to the device.	Attach the SpO_2 cable to the M3500B/ M5500B.
SpO2 Light Interf	The level of ambient light is so high that the sensor cannot obtain an SpO_2 reading, or the sensor or cable is damaged.	1. Cover the sensor with an opaque material. 2. Check the sensor and cable for damage; try another sensor and cable.
Non Pulsatile	The patient's pulse is absent or too weak to be detected.	1. Check that the sensor is applied properly. 2. Make sure the sensor site has a pulse. 3. Relocate the sensor to a site with improved circulation. 4. Try another sensor.
SpO2 Failure	A failure has occurred in the SpO2 circuitry	1. Replace the SpO2 PCA. 2. Ensure that the flex circuit from the SpO2 PCA to the Interface PCA is connected. 3. Replace the SpO2 Connector.
SpO2 Low Signal	SpO_2 signal is too low to give an accurate reading.	1. Check the sensor is applied properly. 2. Try another sensor type.

Table 3-3 System Messages *(Continued)*

Message	Description	Corrective Action
SpO2 Noisy Signal	Excessive patient movement, electrical interference, or optical interference is present.	1. Minimize patient movement or apply the sensor to a site with less movement. 2. Secure the sensor cable loosely to the patient. 3. Reduce sources of electrical or optical interference.
SpO2 Sensor Fail	The SpO_2 cable is not connected to the device; or the cable or sensor are broken.	1. Attach the cable to the M3500B/ M5500B. 2. Replace cable and/or sensor.
System Failure - Cycle Power	A serious error has occurred.	Turn power off, then on. If message reappears, service unit. See "Troubleshooting" on page 3-1.
Service Unit	Appears during the Shift/System Check	1. Replace Data Card. 2. Replace lithium battery. 3. Replace Control PCA.

Momentary Messages

Momentary messages are temporary and only appear on the display for a few seconds. They are intended for the end user and appear in the ***Instructions for Use***. They are duplicated here for the reference of the service person.

Before replacing any parts, check to see if the cables and flex circuits are properly connected. See "Servicing Notes" on page 4-1.

Table 3-4 Momentary Messages

Message	Possible Cause	Corrective Action
Attach Leads	An attempt was made to begin pacing in Demand Mode without ECG leads attached to the patient.	Attach leads to patient
Attach Pads	The multifunction defib electrode pads are not making proper contact with the patient.	1. Check the pads are applied to the patient, as directed on the package. 2. Replace pads if the prompt continues.
Defib Disarmed	The pads connection is compromised. The mode is changed from Manual to AED while the defibrillator is charged. *SHOCK* is not pressed within 30 seconds of the defibrillator being charged. *DISARM* is pressed.	Check the pads are applied to the patient properly. If a shock is indicated, deliver the shock before changing modes. To deliver a shock, press *SHOCK* within 30 seconds of the defibrillator being charged. None.
No Shock Delivered	Patient impedance is too high or too low.	1. Make sure pads are applied properly. 2. Replace the pads. 3. Replace the pads cable.
Check Printer	Printer paper is absent or jammed; the printer door is not closed properly.	1. Reload printer paper. 2. Make sure the door is closed properly.
Data Card Full	The incident is more than 2 hours in duration, causing the Data Card to fill. An empty Data Card was not inserted for the incident; the Data Card filled sooner.	None. A new Data Card can not be inserted during an incident. Use one empty Data Card per incident/patient to decrease the chance of the card filling.
Data Card Interrupted	No data is being recorded on the Data Card because the Data Card was removed during an incident.	• During incident, none. The Data Card cannot be inserted during an incident. • After incident, remove card, turn power off, insert card, turn power on.
Data Card Not In Service	The Data Card is inserted while the M3500B/M5500B is on.	None. A Data Card must be inserted prior to turning the M3500B/M5500B on for the current patient.
Incompatible Data Card	A Data Card other than the M3510A is inserted.	Use only M3510A/M5510A Data Cards.

Table 3-4 Momentary Messages *(Continued)*

Message	Possible Cause	Corrective Action
No Data Card Present	A Data Card is not in the M3500B/ M5500B.	Turn the M3500B/M5500B off and insert a Data Card prior to the first event for the patient.
Key Inactive	The key pressed is currently inactive (i.e. Sync and Pace are inactive in AED Mode).	Use the appropriate mode for the key.
Stop Pacer	Mode is pressed while pacing pulses are being delivered.	Stop pacing before changing the pacing mode.

Audio Tones

The M3500B/M5500B emits tones to alert you to its status.

Table 3-5 Audio Tones

Tone	Meaning	Suggested Action
At power on, a low tone of approx. 1 second followed by a series of higher pitched, short tones.	Normal power on sequence.	None needed.
At power on, a continuous beep of about 7 seconds.	System failure - processors not communicating.	Turn power off, then on. If problem reoccurs, replace Control PCA.
At any time, a repeating tone that alternates between two frequencies.	The unit emits this tone beginning 1 minute before shutdown due to low battery charge.	1. Connect a Power Module or replace the battery with one that is fully charged. 2. Replace Power Module. 3. Service the unit. See "Trouble-shooting" on page 3-1.

Extended Self Test Failures

Should the unit report a *FAIL* in the Extended Self Test, resolve it using the solutions below.

Table 3-6 Extended Self Test Failures

Failure	Possible Cause	Suggested Solution
RAM *ROM* *System* *CODEC* *IRDA* *Timebase*	Failure on Control PCA.	Replace Control PCA.
System FAIL 10	Lithium backup battery failure.	Replace lithium battery.
Data Card	Data Card full, or incompatible, or defective. Failure on Control PCA.	Replace Data Card with new, empty M3510A/M5510A. Replace Control PCA.
Pacer *Defib*	Failure on Power PCA. Failure on Control PCA.	Replace Power PCA. Replace Control PCA.
FE	Failure on Control PCA. Failure on Power PCA. Failure on Interface PCA.	Replace Control PCA. Replace Power PCA. Replace Interface PCA.
SpO2	Failure on SpO_2 PCA. Failure on Control PCA.	Replace SpO_2 PCA. Replace Control PCA.

Operational Problems

These tables describe problems that may arise while using the M3500B/ M5500B.

ECG Monitoring

The following table covers problems that might arise while monitoring ECG.

Table 3-7 Operational Problems - ECG Monitoring (Pads or Leads)

Symptom	Possible Cause	Suggested Solution
Noisy trace - constant noise on the baseline.	Incorrect configuration - power line frequency (50 or 60 Hz) or Filter settings.	Check/change configuration as needed.
	Nearby source of constant interference.	Try moving cable/leads; try relocating unit.
	Failure in ECG front end.	Pads: Replace Power PCA. Leads: Replace Interface PCA.
	Failure in signal processing circuits.	Replace Control PCA.
Noisy trace - intermittent bursts of noise or random spikes.	Nearby source of time-varying interference, such as radio transmitter (paging, walkie-talkies) or X-Ray system.	Try moving cable/leads; try relocating unit.
	Failure in ECG front end.	Pads: Replace Power PCA. Leads: Replace Interface PCA.
	Failure in signal processing circuits.	Replace Control PCA.
Noisy trace - low frequency, periodic.	More than one instrument connected to the patient and active.	Only have one active instrument on the patient at a time.
Flat line - no waveform, no *Leads Off* or *Pads Off* message.	Short in internal ECG wiring or front end.	Pads: 1. Replace Power PCA. 2. Replace Patient Connector + its internal cable. Leads: 1. Replace Interface PCA. 2. Replace ECG connector + internal ECG cable.
	Failure in signal processing circuits.	Replace Control PCA.

Table 3-7 Operational Problems - ECG Monitoring (Pads or Leads) *(Continued)*

Symptom	Possible Cause	Suggested Solution
Leads Off message even though ECG cable has been replaced and is properly connected to the simulator.	Open in internal Leads ECG wiring or front end, due to:	
	Cable from ECG Connector to Interface PCA has bad connection.	Reconnect cable properly. See "Servicing Notes" on page 4-1.
	Defective ECG Connector or cable to Interface PCA.	Replace ECG Connector.
	Defective Interface PCA	Replace Interface PCA.
Pads Off message even though pads cable has been replaced and is properly connected to the simulator.	Open in internal Pads ECG wiring or front end, due to:	
	Cable from Patient Connector to Power PCA has bad connection.	Reconnect cable properly. See "Servicing Notes" on page 4-1.
	Defective Patient Connector or cable to Power PCA.	Replace Patient Connector + its internal cable.
	Defective Power PCA.	Replace Power PCA.
Trace distorted.	Failure in ECG front end.	Pads: Replace Power PCA. Leads: Replace Interface PCA.
	Failure in signal processing circuits.	Replace Control PCA.
One or more ECG controls don't respond (e.g., select lead or ECG size).	Failure in keypress detection/processing.	1. Replace Control PCA. 2. Replace Interface PCA.
	Failure in keys/connections.	Replace Top Case Assembly.
Poor Leads ECG signal quality.	The monitoring electrodes are not making proper contact with the patient.	Check that the monitoring electrodes are properly applied. If necessary, prepare the patient's skin and apply new electrodes.
	The monitoring electrodes are outdated or dried-out.	Check the date code on the electrodes. Do not open the electrode package until immediately prior to use.
	Radio frequency interference (RFI) is causing artifact.	Relocate or turn off equipment that may be causing RFI.

Table 3-7 Operational Problems - ECG Monitoring (Pads or Leads) *(Continued)*

Symptom	Possible Cause	Suggested Solution
Poor Pads ECG signal quality.	The multifunction pads are not making proper contact with the patient.	Check that the pads are properly applied. If necessary, prepare the patient's skin and apply new pads.
	The multifunction pads are outdated or dried-out.	Check the date code on the pads. Do not open the pads package until immediately prior to use.
	Radio frequency interference (RFI) is causing artifact.	Relocate or turn off equipment that may be causing RFI.
QRS beeper inaudible or beeps do not occur with each QRS complex.	The QRS beeper is configured to **Off**.	Configure the QRS beeper to **On**.
	The volume is set too low.	Adjust the volume.
	The amplitude of the QRS complex is too small to detect.	Adjust the size of the ECG.
Fails ECG Test in Diagnostic Mode.	Failure in Pads ECG front end or signal processing.	1. Replace Power PCA. 2. Replace Control PCA.
	Failure in Leads ECG front end or signal processing.	1. Replace Control PCA. 2. Replace Interface PCA.

SpO_2 Monitoring

The following table covers problems that might arise while monitoring SpO_2.

Table 3-8 Operational Problems - SpO_2 Monitoring

Symptom	Possible Causes	Suggested solution
No response - no value on screen, no pleth bar.	Bad internal connection.	Carefully reseat flex cables between SpO_2 connector and SpO_2 PCA, and between SpO_2 PCA and Interface PCA. See "Servicing Notes" on page 4-1.
	SpO_2 PCA failure.	Replace SpO_2 PCA.
	Control PCA failure.	Replace Control PCA.
	Interface PCA failure.	Replace Interface PCA
Reads obviously wrong value.	Same as above.	Same as above.
Noisy/intermittent signal	Same as above.	Same as above.

Defibrillation and Cardioversion

The following table covers problems that might arise while defibrillating or delivering synchronized cardioversion.

Table 3-9 Operational Problems - Defibrillation and Synchronized Cardioversion

Message or Symptom	Possible Causes	Suggested solution
Won't charge in Manual Mode.	• Pads connector or internal wiring failure. • Power PCA failure. • Control PCA failure. • Interface PCA failure. • *CHARGE* key failure.	Diagnose as follows: 1. Try AED Mode. • Charges OK: Go to step 3. • Still not charge: Go to step 2. 2. Verify Pads Off and Cable Off detection by unplugging pads, cable. • Detects both OK: Go to step 3. • Either Pads Off or Cable Off fail: replace 1) Pads connector 2) Power PCA. 3. In Diagnostic Mode, run Controls Test and test *CHARGE* key. • Key tests OK: Replace Control PCA. • Key not OK: Replace 1) Interface PCA 2) Top Case Assembly 3) Control PCA.
Won't charge in AED Mode.	• Pads connector or internal wiring failure. • Power PCA failure. • Control PCA failure. • Interface PCA failure. • *CHARGE* key failure.	Diagnose as follows: 1. Try Manual Mode • Charges OK: Go to step 3. • Still not charge: Go to step 2. 2. Verify Pads Off and Cable Off detection by unplugging pads, cable. • Detects OK: Go to step 3. • Either Pads Off or Cable Off fail: replace 1) Pads connector 2) Power PCA. 3. In Diagnostic Mode, run Controls Test and test *CHARGE* key. • Key tests OK: Replace Control PCA. • Key not OK: Replace 1) Interface PCA 2) Top Case Assembly 3) Control PCA.

Table 3-9 Operational Problems - Defibrillation and Synchronized Cardioversion *(Continued)*

Message or Symptom	Possible Causes	Suggested solution
Won't discharge.	• Control PCA failure. • Interface PCA failure. • *SHOCK* key failure.	Diagnose as follows: 1. In Diagnostic Mode, run Controls Test and test *SHOCK* key. • Key tests OK: Replace Control PCA. • Key not OK: Replace 1) Interface PCA 2) Top Case Assembly 3) Control PCA.
Charges, but disarms when press *Shock*.	Patient impedance sensed as too high or too low during energy delivery due to: • Pads losing contact with patient. • Pads failure. • Pads cable failure. Power PCA failure. Control PCA failure.	Replace pads, pads cable. Replace Power PCA Replace Control PCA
Charges, but disarms spontaneously.	1. Unit sensed *Pads Off* or *Cable Off* due to: • Pads losing contact with patient. • Pads failure. • Pads cable failure. • Power PCA failure. • Control PCA failure. • Interface PCA failure. 2. *DISARM* key failure (intermittent)	Replace pads, pads cable. Diagnose further as follows: In Diagnostic Mode, run Controls Test and test *DISARM* key. • Key tests OK: Replace 1) Power PCA 2) Control PCA. • Key not OK: Replace 1) Interface PCA 2) Top Case Assembly3) Control PCA.
Charges slowly - about 4-5 sec. instead of 2-3 sec.	Battery too old or not fully charged. Unit senses unsupported battery due to: • Unsupported battery in use • Battery PCA failure. • Power PCA failure. • Control PCA failure.	Replace with new, fully charged battery. Also run Battery Capacity Test on suspect battery (see page 2-31). Use only supported battery (M3516A/M5516A). Diagnose further as follows: In Diagnostic Mode, start Battery Capacity Test (see page 2-31). • "*Unsupported battery*" on display: Stop test. Replace 1) Battery PCA 2) Power PCA 3) Control PCA. • No message on display: Stop test. Replace 1) Power PCA 2) Control PCA.

Table 3-9 Operational Problems - Defibrillation and Synchronized Cardioversion *(Continued)*

Message or Symptom	Possible Causes	Suggested solution
Doesn't deliver correct energy into Defibrillator Analyzer or delivers no energy at all. (Should also get message - *No shock delivered* or *Defib failure*.)	Control PCA failure. Power PCA failure.	Replace Control PCA. Replace Power PCA.
Doesn't measure its own delivered energy correctly.	Power PCA failure. Control PCA failure.	Replace Power PCA. Replace Control PCA.
Not synchronizing even though ECG waveform OK on display.	Control PCA failure.	Replace Control PCA.
Fails *Defib Meas* Test in Diagnostic Mode (other then symptoms above).	Power PCA failure. Control PCA failure.	Replace Power PCA. Replace Control PCA.

Pacing

The following table covers problems that might arise while performing external pacing.

Table 3-10 Operational Problems - Pacing

Message or Symptom	Possible Causes	Suggested solution
Doesn't deliver correct current into Pacer Tester or delivers no current at all.	Control PCA failure. Power PCA failure.	Replace Control PCA. Replace Power PCA.
Doesn't measure its own delivered current correctly.	Power PCA failure. Control PCA failure.	Replace Power PCA. Replace Control PCA.
Doesn't pace at correct rate.	Control PCA failure.	Replace Control PCA.
Pacer hardware not installed. message even though Pacer is present.	Bad connections - Manual Keypad flex circuits to Interface PCA.	Reconnect flex circuits properly. See "Servicing Notes" on page 4-1.
Unit fails either the Shift System Check or Extended Self Test, or reports error code 90007.	Test sequence is interrupted.	Run the test again, making sure that no one touches the unit during the test.

Printer

The following table covers problems that might arise while printing. Before replacing any parts, check to see if the cables and flex circuits are properly connected. See "Servicing Notes" on page 4-1. Also check for damage to the printer ribbon cable where the ribbon is captured in the connectors.

Table 3-11 Operational Problems - Printer

Symptom	Possible Causes	Suggested solution
Paper won't move.	Paper improperly loaded or jammed, or paper is wet.	Reload paper or clear jam. If paper is wet, replace with fresh dry roll.
	Printer failure.	Replace printer.
Paper moves then stops.	Door improperly latched.	Check door latch.
	Paper improperly loaded or jammed.	Reload paper or clear jam.
Paper moves but printing is faint or absent.	Door improperly latched.	Check door latch.
	Dirty printhead.	Clean printhead.
	Printer failure.	Replace printer.
	Control PCA failure.	Replace Control PCA.
Paper moves but print quality poor or some dots missing.	Dirty printhead.	Clean printhead. See"Cleaning the Printer Printhead" on page 4-9.
	Printer failure.	Replace printer.
Loud buzzing or grinding noise.	Door improperly latched.	Check door latch.
Waveforms or text distorted even though they look OK on display.	Printer failure.	Replace Printer.
	Control PCA failure.	Replace Control PCA.
Black line running along paper.	Dots (printhead elements) stuck on due to:	
	Printer failure.	Replace Printer.
	Control PCA failure.	Replace Control PCA.
White line running along paper.	Dirt on printhead.	Clean printhead. See "Cleaning the Printer Printhead" on page 4-9.
	Dots (printhead elements) stuck off due to:	
	Printer failure.	Replace Printer.
	Control PCA failure.	Replace Control PCA.
Fails Printer Test in Diagnostic Mode (other then symptoms above).	Printer failure.	Replace Printer.
	Control PCA failure.	Replace Control PCA.

Display

The following table covers problems that might arise with the LCD display. Before replacing any parts, check to see if the cables and flex circuits are properly connected. See "Servicing Notes" on page 4-1.

Table 3-12 Operational Problems - Display

Symptom	Possible Causes	Suggested solution
No response - all white or all black.	Contrast misadjusted. Control PCA failure. Display failure.	Adjust contrast. Replace Control PCA. Replace Display.
Display is blank but backlight works.	Bad connections involving Display Data Cable. Display failure. Control PCA failure.	1. Check/reseat data cable. 2. Replace data cable Replace Display. Replace Control PCA.
Backlight doesn't light in dark ambient conditions.	• Display failure. • Control PCA failure. • Ambient light sensor failure.	Diagnose as follows: In Diagnostic Mode, run Display Test and press *BACKLIGHT ON* and *BACKLIGHT OFF* softkeys. • Backlight does not respond: Replace 1) Display 2) Control PCA. • Backlight responds normally: test Ambient Light Sensor (below). In Diagnostic Mode, run Display Test and check ambient light readings. • Normal: Replace 1) Display 2) Control PCA. • Abnormal or not responding: Replace 1) Control PCA 2) Interface PCA.
Contrast does not adjust for ambient temperature.	Display failure. Control PCA failure.	Replace Display. Replace Control PCA.
Fails Display Test in Diagnostic Mode (display problem other then symptoms above).	Display failure. Control PCA failure.	Replace Display. Replace Control PCA.
Fails Display Test in Diagnostic Mode (ambient light readings).	Control PCA failure. Interface PCA failure.	Replace Control PCA. Replace Interface PCA.
Fails Display Test in Diagnostic Mode (backlight).	Display failure. Control PCA failure.	Replace Display. Replace Control PCA.

Table 3-12 Operational Problems - Display *(Continued)*

Symptom	Possible Causes	Suggested solution
Fails Display Test in Diagnostic Mode (indicator LEDs).	Control PCA failure.	Replace Control PCA.
	Manual Keypad failure.	Replace Manual Keypad.

Audio

The following table covers problems that might arise with the audio tones or voice prompts. Before replacing any parts, check to see if the cables and flex circuits are properly connected. See "Servicing Notes" on page 4-1.

Table 3-13 Operational Problems - Audio Tones/Voice Prompts

Symptom	Possible Causes	Suggested solution
No audio at all.	Speaker failure.	Replace Speaker Assembly.
	Control PCA failure.	Replace Control PCA.
Audio is distorted.	Damage to speaker label.	Replace speaker label.
	Speaker failure.	Replace Speaker Assembly.
	Control PCA failure.	Replace Control PCA.
Buzzing noise when audio active.	Damage to speaker label.	Replace speaker label.
	Debris between speaker and speaker label.	Remove speaker label, clean out debris, install new speaker label.
	Speaker hardware loose.	Tighten hardware as needed.
	Speaker failure.	Replace Speaker Assembly.
	Control PCA failure.	Replace Control PCA.
Tones present but no voice prompt (in AED Mode).	Control PCA failure.	Replace Control PCA.
Voice prompt present but no tones.	Control PCA failure.	Replace Control PCA.

Keys

The following table covers problems that might arise with the keypads. Before replacing any parts, check to see if the cables and flex circuits are properly connected. See "Servicing Notes" on page 4-1.

Table 3-14 Operational Problems - Keys

Symptom	Possible Causes	Suggested solution
ON key doesn't respond.		Refer to Table 3-1 "Unit Unresponsive".
One or more of the Main Keys fails to respond (*OFF, 1, 2, 3*).	• Key failure. • Interface PCA failure. • Control PCA failure.	Diagnose as follows: In Diagnostic Mode, run Controls test and identify all unresponsive keys. • Some keys don't respond: Replace 1) Control PCA 2) Interface PCA 3) Top Case Assembly. • All keys don't respond: Replace 1) Control PCA 2) Interface PCA
One or more of the other keys don't respond (display controls, printer controls, manual/pacing).	• Key failure. • Interface PCA failure. • Control PCA failure.	Diagnose as follows: In Diagnostic Mode, run Controls test and identify all unresponsive keys. • Some keys don't respond: Replace 1) Interface PCA 2) Control PCA 3) Top Case Assembly. • All keys don't respond: Replace 1) Interface PCA 2) Control PCA.
Fails Controls Test in Diagnostic Mode	See symptoms above.	

Battery and Power Modules

The following table covers problems that might arise with the Battery or Power Module. Refer to Figure 3-3 to identify the indicators. Refer to Table 3-16 for the different combinations of indicator illuminations.

Table 3-15 Operational Problems - Battery, AC or DC Power Modules, Battery Charger Adapter

Symptom	Possible Causes	Suggested solution
Low battery life (depletes quickly in use).	Very frequent use - not charging long enough between uses.	Charge fully between uses. Use spare batteries and adapters as needed to allow complete charging.
	Battery failure.	Run Battery Capacity Test (see "Battery Capacity Test" on page 2-31). If battery fails test, replace battery.
	Power module failure.	Replace Power Module.
	Failure on Control PCA, Power PCA, or Battery PCA.	Replace 1) Control PCA 2) Power PCA 3) Battery PCA.
Charging indicator doesn't come on when Power Module plugged into Battery Charger Adapter or into M3500B/M5500B.	Power module failure.	Replace Power Module.
Fails Battery Capacity Test	Battery old, worn out, or failed.	Replace battery.
	Failure on Control PCA.	Replace Control PCA.
Done indicator doesn't come on even after plenty of charging time (>14.5 hours).	Performing System/Shift Test resets the Power Module's charging clock - thus "Done" never illuminates even though battery is charged.	Use spare batteries and adapters as needed to allow complete charging.
	Battery failure.	Run Battery Capacity Test (see "Battery Capacity Test" on page 2-31). If battery fails test, replace battery.
	Power Module failure.	Replace Power Module.
"Unsupported Battery" message appears on the screen	• Not an M3516A battery.	• Use an M3516A battery only.
	• Battery damage.	• Replace the battery.
	• Failure on battery PCA.	• Replace the Battery PCA.

Figure 3-3 Power Module Indicators

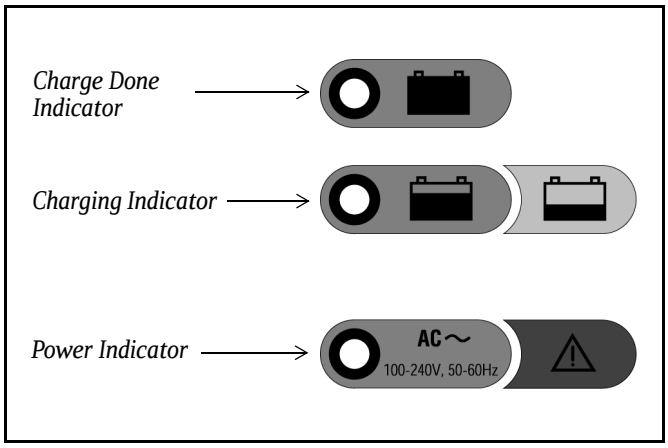


Table 3-16 Power Module Indicator Matrix

INDICATORS			SYSTEM STATE				MEANING
POWER	CHARG-ING	DONE	Con-nected to Mains (AC/DC) ?	Con-nected M3500B/ M5500B ?	Battery in Place?	Unit Power ON ?	
R = RED G = GREEN OR = ORANGE/AMBER			Y = YES N = NO --- = don't care				
OFF	OFF	OFF	N	---	---	---	Normal
G	OFF	OFF	Y	---	---	---	Normal
G	OFF	OFF	Y	Y	N	---	Normal
G	OR	OFF	Y	Y	Y	---	Battery is charging.
G	G	OFF	Y	Y	Y	---	Battery 90% charged.
G	G	G	Y	Y	Y	---	Battery fully charged.
R	OFF	OFF	Y	Y	---	---	If Power light was green before connecting to unit, fault in M3500B/M5500B.
R	OFF	OFF	Y	N	---	---	Mains voltage low or Fault in Power Module.

Data Card

The following table covers problems that might arise with the Data Card.

Table 3-17 Operational Problems -Data Card

Symptom	Possible Cause	Corrective Action
Data card is not recognized when plugged in.	Unit power is already on. Card is only recognized during power-up sequence. Card is full or not a supported type.	Turn power off for 2 minutes, then on again. Use a new, empty M3510A/M5510A Data Card.
Data on the card corrupted.	The card was removed while the unit power on.	Only remove card after power is turned off. Delete corrupted files using the Event Review Data Management System.
Fails Data Card Test in Diagnostic Mode	Card is full or not a supported type. Failure on Control PCA.	Use a new, empty M3510A/M5510A Data Card. Replace Control PCA.

Calling for Service - Philips HeartStart XLT

For telephone assistance, call the Philips Medical Systems Response Center nearest to you, or visit our website at: www.medical.philips.com/cms.

United States of America

Medical Response Center	Tel: (800) 548-8833

Latin America

Medical Response Center	Tel: 954-835-2600

Canada

Medical Response Center	Tel: 800-323-2280

Other International Areas

Australia	France
Tel: 131147	Tel: 0803 35 34 33

Germany	Italy
Tel: 0180 5 47 50 00	Tel: 800-825087

Netherlands	United Kingdom
Tel: 31 20 547 2555 Fax: 31 29 547 2949	Tel: 00 44 7002 432584

Belgium (for Dutch)	Belgium (for French)
Tel: 32 2 525 7102 Fax: 32 2 525 71 91	Tel: 32 2 525 710 3 Fax: 32 2 525 71 91

Spain	Poland
Tel: 34 902 30 40 50 Fax: 34 91 326 39 66	Tel: 48 22 5710499

Austria	Finland
Tel: 43 1 60101 820	Tel: 09 6158 0400

Switzerland	Russia
Tel: 0800 80 10 23	Tel: 7 095 933 0339 Fax: 7 095 933 0338

Calling for Service - Laerdal Heartstart 4000

For telephone assistance, call the Laerdal office nearest to you, or visit our website at: www.medical.philips.com/cms.

United States of America

Laerdal Medical Corporation	Tel: (800) 547-4781

International Customers

Australia	United Kingdom
Tel: 61-3-95694055	Tel: 44-1689-876634

Norway	Other International Areas
Tel: 946-71-700	Tel: 47-51511700

4 Removal and Replacement

Overview

This chapter provides procedures for removing and replacing the subassemblies that are available as replacement parts.

Servicing Notes

Following are some important points to keep in mind whenever servicing the M3500B/M5500B.

Key Components

Replacement assemblies marked with an asterisk (" * ") in the Replacement Parts tables contain one or more Key Components. Key Components require detailed tracking, by recording the key component part number and either the key component's date code or its serial number. This data must be recorded for both the failed assembly and the replacement assembly.

Philips Medical Systems service personnel must record this information on the Customer Service Order (CSO).

The Key Components that are part of the replacement assemblies are listed in Table 5-15 on page 5-20.

Removal, Handling, and Replacement

The following sections give details of how to successful work with the internal assemblies of the M3500B/M5500B.

Flex Circuit Connections

In order for flex connections to function properly, they must be disconnected and reconnected as follows:

- Always unlatch the PCA-mounted connector before removing the flex, and hold the latch open while reinserting the flex into the connector.

- When reconnecting, align the flex carefully in its receptacle, making sure it is both centered from side to side in the connector, and oriented at 90 degrees to the connector.
- Be sure the flex is fully seated in the connector and the connector is properly latched.

Flex Circuit Handling

The flex circuits are delicate and can be damaged by improper handling:

- Do not bend sharply.
- Do not scrape the contact surface against other parts.
- Handle the flex with bent tip needle nose pliers whose jaws are covered with a soft material (such as plastic tubing or tape).

Internal Connections

Whenever troubleshooting indicates a particular PCA may be at fault, it is always good practice to check all the connections to that PCA carefully before replacing the PCA.

Cable and Assembly Placement

How the wires and cables are routed and dressed inside the chassis plays an important role in two areas: in preventing long term wear problems, and in reducing electromagnetic and radio frequency interference emitted by the defibrillator.

- When you disassemble any part of the defibrillator, pay special attention to how cables and wires are routed.
- When you reassemble the defibrillator, be sure to route and dress all cables and wires as they were originally.
- Return all components to their former position within the case.

Instrument Reassembly

If you do not reassemble the instrument correctly, the instrument may no longer be properly sealed. This could result in water damage to the defibrillator. Be sure to maintain the water-resistant seal by:

- Replacing all gaskets in their proper locations.
- Correctly assembling all parts that mate with gaskets (making sure the gaskets are not wrinkled or pinched).
- Replacing all screws.
- Making sure that screws are not cross-threaded and that they are tightened firmly.

Tool Requirements

The following tools are needed to perform the procedures given.

- Torx T10 and T15 drivers (or Torx driver kit, Philips part number 5181-1933). T15 driver shaft should be at least 2.25" long and less than 5/16" in diameter to reach down to recessed case screws.
- Phillips #1 screwdriver.
- Small straight bladed screwdriver.
- Straight tip needle nose pliers or tweezers.
- Bent tip needle nose pliers whose jaws are covered with a soft material (such as plastic tubing or tape).
- Fine nose wire cutters.
- Utility knife.
- High voltage discharge tool for discharging the defibrillator capacitor (Philips part number M2475-69572).
- Clip leads (at least 2, each approx. 10-18").
- Language Support Tool (see Table 5-2 on page 5-7 part numbers)

User-replaceable Parts and Accessories

The ***Instructions for Use*** gives detailed instructions on replacing the following:

- Patient cables & sensors
- Battery
- Printer paper

For the convenience of the service person, instructions on replacing the Manual Door and the Carrying Case are duplicated here.

Manual Door

The following instructions detail how to remove and replace the Manual Door. Refer to Table 5-6 on page 5-9 to select the correct replacement.

Removal

1. Open the door to a vertical position as shown in Figure 4-1.
2. Pull the hinge end of the door away from the case. It will snap free.

Replacement

1. If you are installing a new door, install the new labels as follows
   a. Clean both top and bottom door surfaces with isopropyl alcohol. Allow them to dry.
   b. Lay the door on a clean flat surface with its underside facing up (the side that is concealed when the door is closed).
   c. The new door will come with labels both for units with Pacing and without Pacing. Select the correct label for your unit.
   d. Peel the new *Manual Operation* label off the backing material.
   e. Starting with the top edge, align the label carefully with the recess on the door and roll it down slowly into place. When installed, it should be as shown in Figure 4-3.
   f. Press firmly all over, especially the edges, to adhere the new label into place.
   g. Turn the door over to expose its top surface.
   h. Peel the new *Manual* label off the backing material.
   i. Starting with the top edge, align the label very carefully with the recess on the door and roll it down slowly into place.
   j. Press firmly all over, especially the edges, to adhere the new label into place.
2. Align the door with the door hinges as shown in Figure 4-1.

3. Push, as shown in Figure 4-2, until the door snaps into place.

Figure 4-1 Aligning the Manual Door

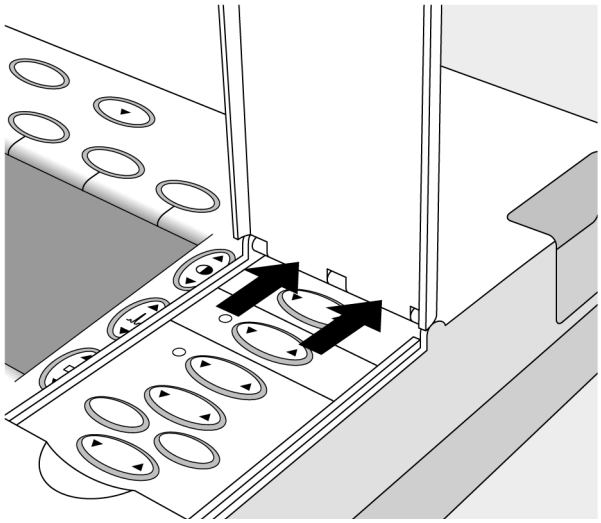


Figure 4-2 Snapping the Door in Place

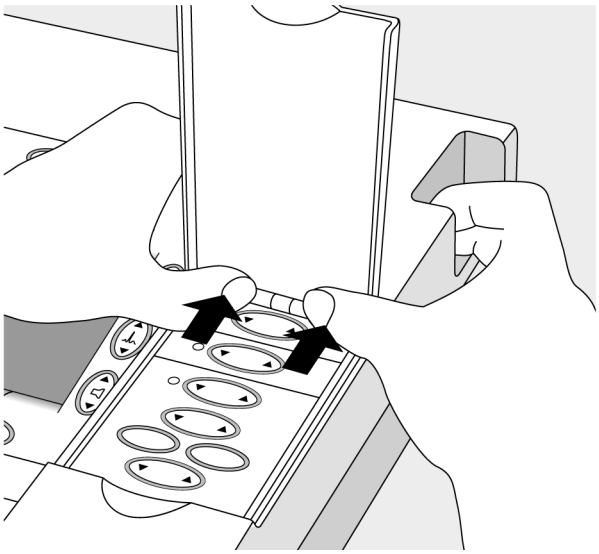
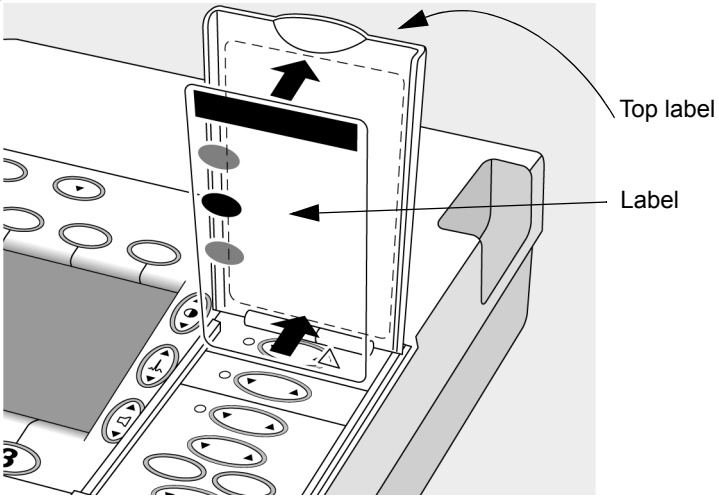


Figure 4-3 Attaching the Door Labels



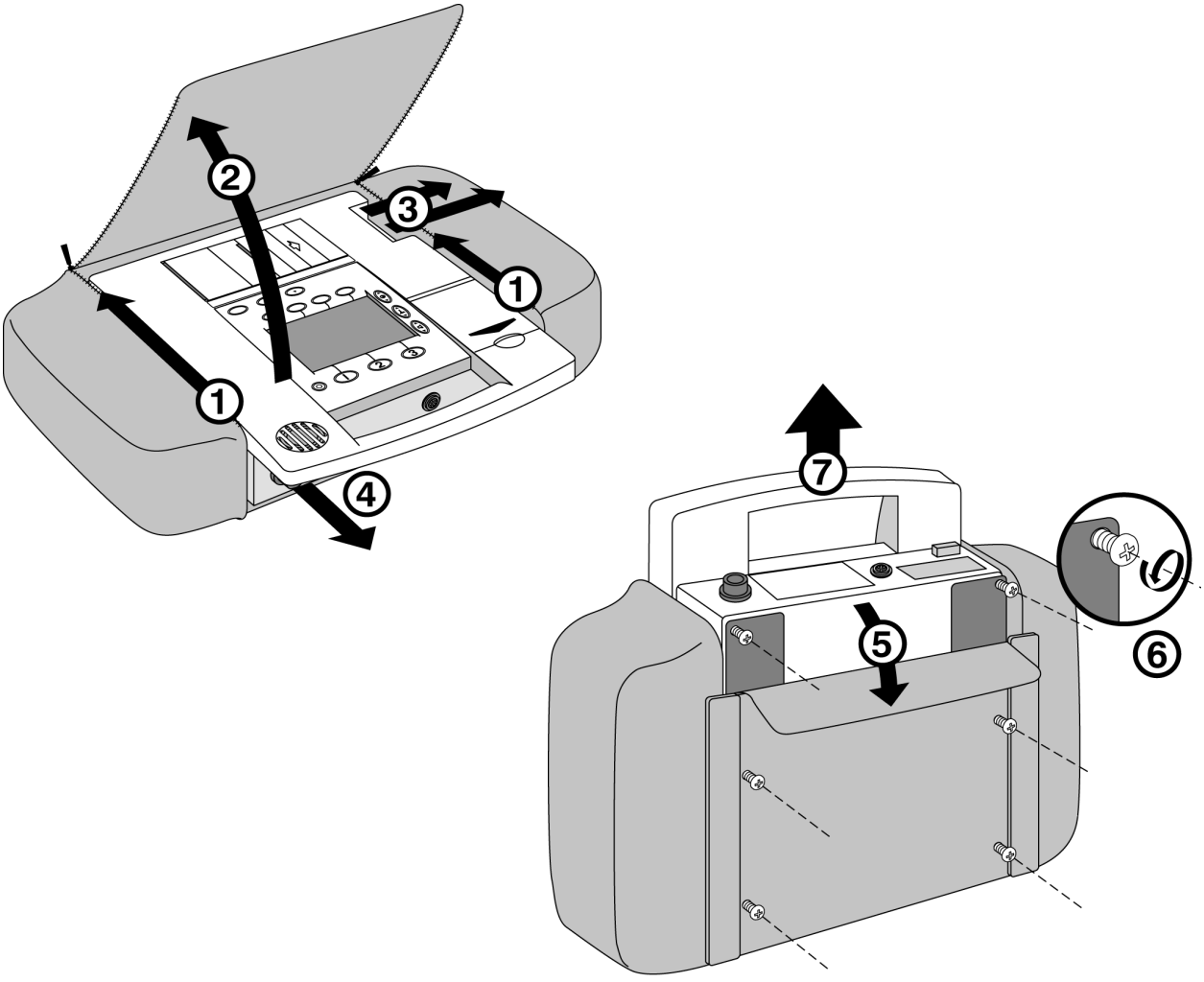
Carrying Case

Removal

To remove the carrying case from the M3500B/M5500B, follow steps 1 through 7 as shown in Figure 4-4. Note the screws are Phillips head, not Torx.

Also, after loosening the captive screws (step 6), lay the unit flat and lift the defibrillator up off the mounting plates to disengage it from the 2 locating pins in the carrying case. Then slide it out of the carrying case as shown in step 7.

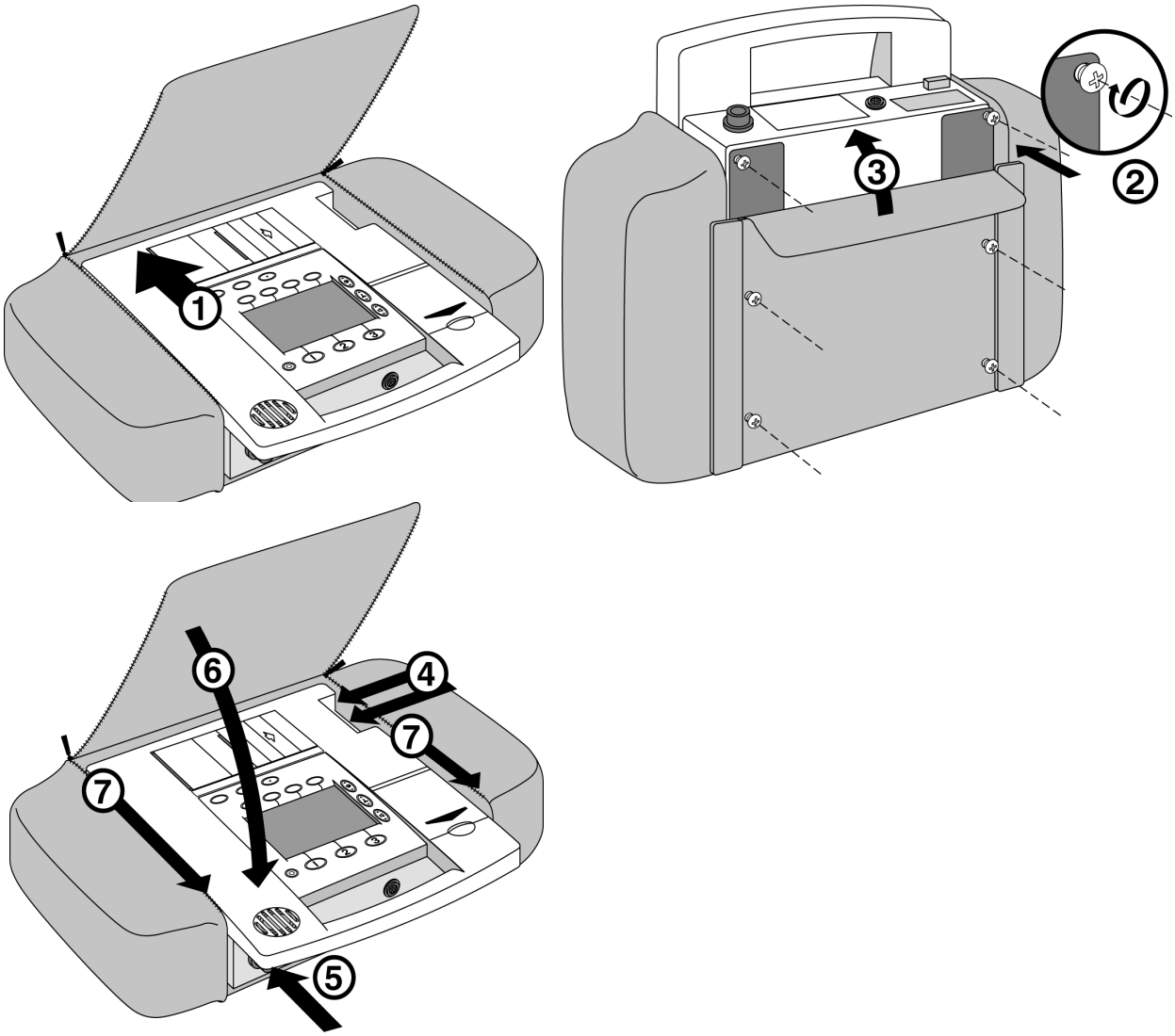
Figure 4-4 Removing the Carrying Case



Replacement

To install the carrying case on the M3500B/M5500B, follow steps 1 through 7 as shown in Figure 4-5. Slide the unit into the case as shown in step 1, then lower it onto the 2 locating pins in the case before tightening the screws in step 2.

Figure 4-5 Installing the Carrying Case



User Maintenance

The ***Instructions for Use*** gives detailed instructions on maintaining and cleaning the M3500B/M5500B, including:

- Operational Checks
- Battery Maintenance
- Cleaning Instructions

For the convenience of the service person, instructions on cleaning the printer printhead are duplicated here. Instructions on running the Battery Capacity Test are duplicated on page 2-31.

Cleaning the Printer Printhead

If the printout has light or varying density printing, clean the printhead to remove any buildup of paper residue.

To clean the printhead:

1. Slide the printer door to the right until the paper roller pops up.
2. Pull up on the plastic removal tab to remove the roll of paper.
3. Clean the printhead surface (above the brush) with a cotton swab dipped in isopropyl alcohol.
4. Replace the roll of paper.

External Assemblies

This section describes how to remove and replace assemblies that are external to the sealed case.

Not all the assemblies described here are available as replacement parts; see the "Replacement Parts" chapter.

CAUTION

Be sure to work in a static safe environment. The work surface and area surrounding it must be static free. Use a static control wrist band, in conjunction with an antistatic pad which is grounded per the manufacturer's instructions.

Printer Assembly

The following steps describe how to remove and replace the printer assembly.

Removal

1. Disconnect the Power Module and remove the battery.
2. Discharge the power supply capacitors by turning the power on. You will hear a click from the speaker.
3. Open the door over the paper by moving the sliding door in the direction of the arrow and lifting up the platen and roller.
4. Loosen the (2) T10 screws now visible on the top and bottom edges of the printer assembly at the left end. See Figure 4-6.
5. Peel up the label with the arrow on it.
6. Loosen the (2) T10 screws under the label
7. Pull the printer assembly and its screws straight upward
8. Unlatch the ribbon cable and unplug it as shown in Figure 4-7.

Figure 4-6 Removing the Printer Label and Screws

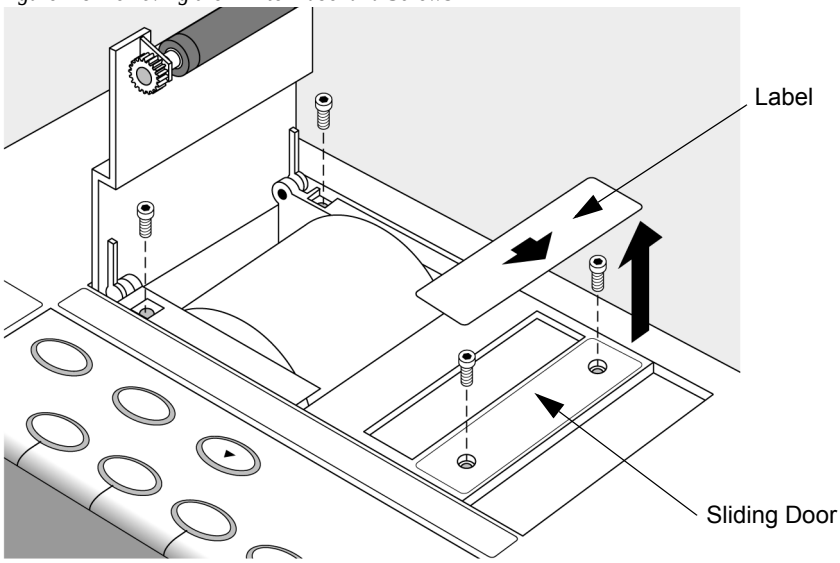
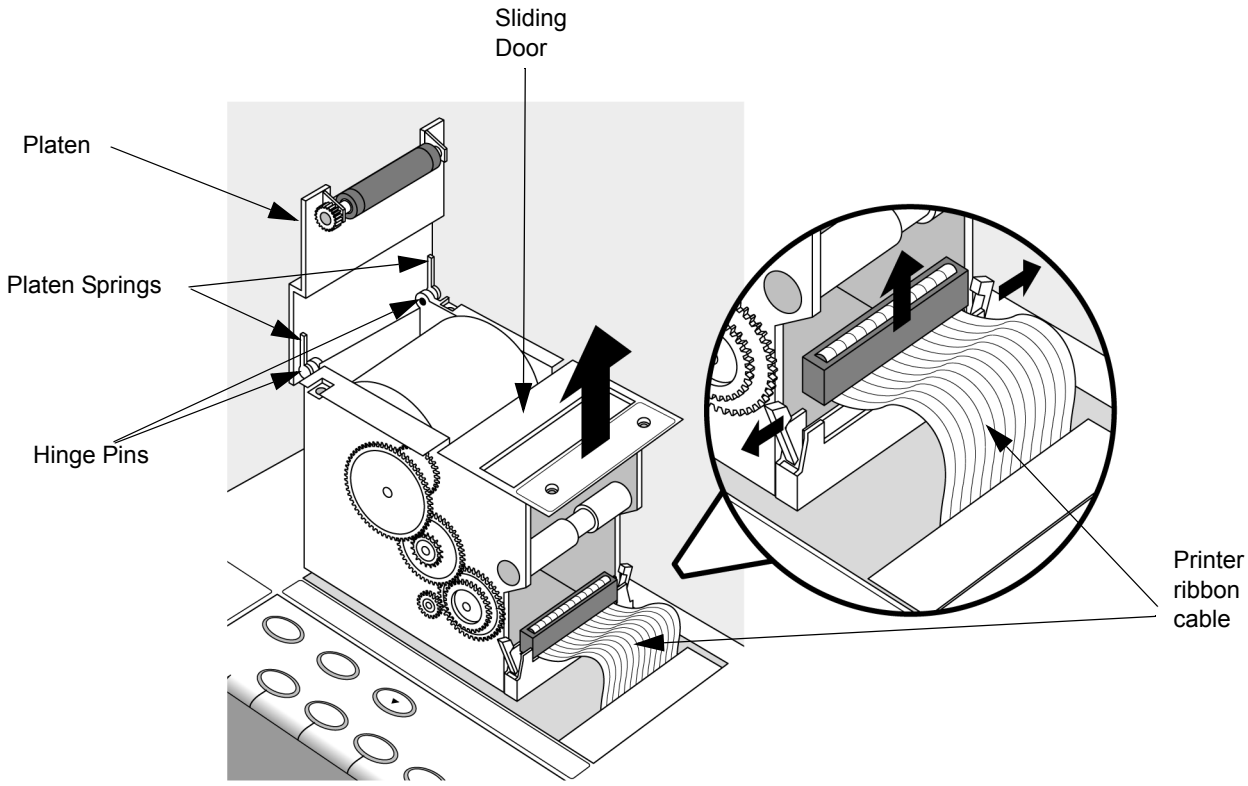


Figure 4-7 Removing the Printer



Replacement

1. The replacement printer ships with a grey sliding door and a grey platen installed. They must be replaced with the yellow sliding door and yellow platen that came in the printer kit. Refer to "Printer Sliding Door" and "Printer Platen" on page 4-13.
2. Open the paper door on the new printer. Leave the paper door open until the screws under the label are tightened.
3. Put the 4 screws in the holes in the new printer. Get the 2 screws back in the holes under the label with tweezers or fine nose pliers.
4. Reconnect the ribbon cable. Be sure to engage the 2 latches on the ends of the ribbon connector.
5. Lower the printer straight down into the instrument.
6. Tighten all screws.
7. Clean the surface where label will be placed with alcohol. Allow it to dry.
8. Replace the label.

Printer Sliding Door

Removal

a. Turn the printer upside down on a flat surface. Orient it so that the sliding door is nearest you. Note how the 2 springs are installed on the sliding door and how the metal door limit is used to stop the travel of the sliding door (the springs are identical).

b. Using a pair of needle-nose pliers, remove and save both springs.

c. Lift the metal door travel limiter up and slide the door forward, away from the printer.

d. Slide the door out on its rails as far as it will go. Pull the retaining clips on one side of the door out away from the side of the printer frame to unsnap the door from the printer.

Replacement

a. Starting at the end of the rails furthest out from the printer, hook the retaining clips on one side of the door over the rail and snap the clips on the other side of the door into place. This is made easier by pulling out on the retaining clips to spread them further apart, and by squeezing the printer frame to deflect the rails toward each other.

b. Lift the metal door travel limiter up and slide the door in toward the printer all the way to the end of its rails.

c. Reattach the two springs, with their round ends hooked through the holes in the frame, and their angled ends hooked over the lugs on the underside of the door. Note that the springs should be behind the metal door limit.

Printer Platen

Removal

a. Open the printer. If you have just removed the sliding door, it will already be open.

b. Note the two platen springs (they are ***not*** identical), and how they are located. Their longer ends fit into grooves in the platen; their shorter ends fit through a slot in the printer frame.

c. Grasp the body of the printer just below the hinge pins and squeeze the body so that the hinge pins move in. Disengage one pin first, then the other.

d. Lift the platen assembly from the hinges. Keep track of the springs.

Replacement

a. Reinstall the springs on their correct hinge pins.

b. Grasp the body of the printer just below the hinge pins and squeeze the body so that the hinge pins move in. First engage one pin to the new platen, then the other. Be sure the springs are installed correctly.

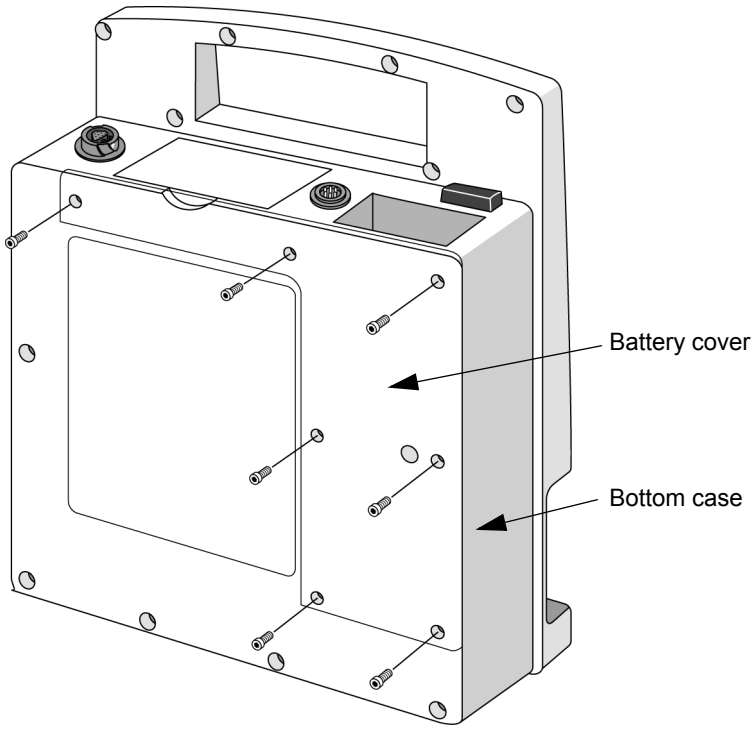
Battery Cover

The instructions that follow describe how to remove and replace the battery cover.

Removal

1. If necessary, remove the unit from its carrying case.
2. Remove the battery.
3. Turn the unit upside down with the handle facing you. The battery cover is at left side of the bottom surface. Note that Figure 4-8 shows the case standing up for clarity.
4. Remove the 7 screws as shown in Figure 4-8. The screws are size-coded; only remove the T10 size.
5. Lift battery cover up.

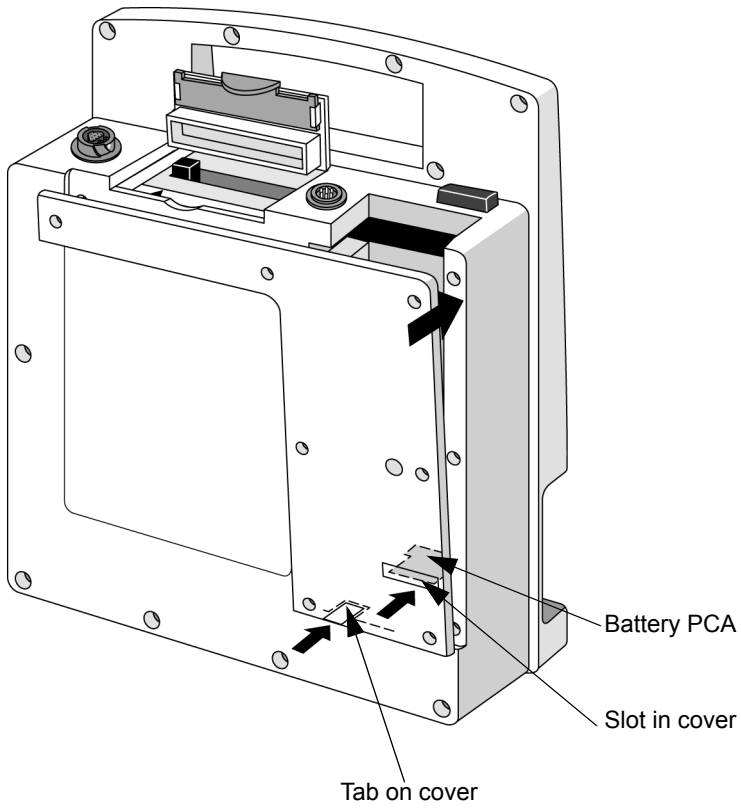
Figure 4-8 Removing the Battery Cover



Replacement

1. Ensure the lower edge of the battery PCA is seated in its slot in the case and that the battery spring is in its slot. Correct orientation of the Battery Eject Spring is angled slightly toward the Battery PCA, and NOT angled up out of the battery compartment. Adjust the angle of the spring as needed by turning it while keeping it in place in its slot.
2. Carefully insert a battery in the battery compartment. Be sure the battery stays flat and does not push up out of position.
3. While keeping the battery in place, replace the battery cover starting with the end by the battery PCA. See Figure 4-9, which shows the case standing upright for clarity. Insert the tab on the cover into the mating slot next to the battery spring. Then lower the cover into position, allowing the square post on the cover to mate with the recess in the case next to the Power Connector.
4. Replace all screws and tighten.

Figure 4-9 Installing the Battery Cover



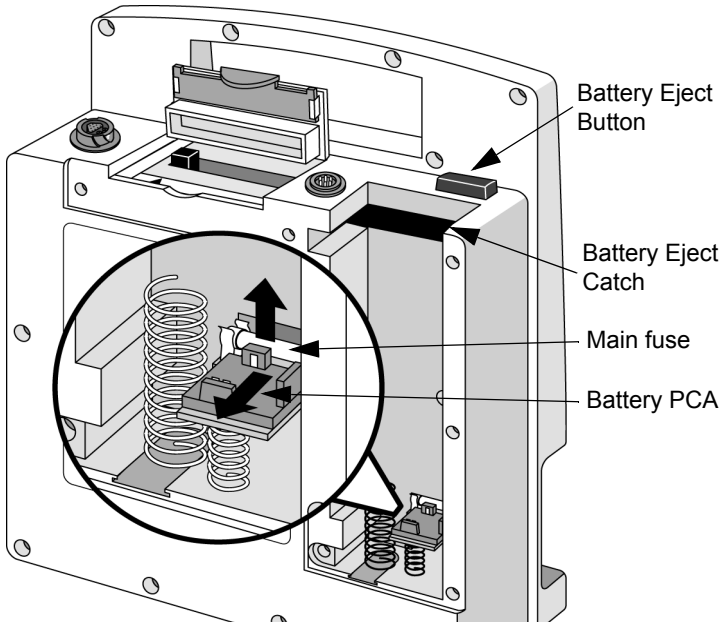
Main Fuse

The main fuse is located on the Battery PCA, which is under the Battery Cover.

Removal

1. Remove the battery cover as described under "Battery Cover" on page 4-15.
2. Pull out the Battery PCA far enough to access the fuse.
3. Remove the fuse by pulling straight up from PCA as shown in Figure 4-10.

Figure 4-10 Removing the Main Fuse



Replacement

1. Snap the new fuse into position.
2. Push the Battery PCA back into position, being sure the lower edge of the PCA engages the slot in the bottom case.
3. Replace the battery cover as described under "Battery Cover" on page 4-15.

Battery Eject Assembly

The Battery Latch engages when the battery is fully inserted in the battery compartment, and it is released by pushing the Battery Eject Button.

Removal

1. Remove the battery cover as described under "Battery Cover".
2. Press the Battery Eject Button all the way in and hold it in. Using a small flat bladed screwdriver, press in the catch on the Eject Button and slide

the Eject Button out of the case. The catch is located in the narrow slot in the bottom case that points to the eject button. Note the orientation of the Eject Button.

3. Pull the Battery Eject Catch up out of its slot in the case. There will be a long spring inside the catch. Note the orientation of the catch in its slot.

Replacement

1. Insert the new Battery Catch Spring into the hole in the end of the new Battery Eject Catch.
2. Install the Battery Eject Catch into its open slot in the bottom case, with the spring on the end furthest from the Eject Button and the triangular plastic catch facing up toward you through the top of the open slot.
3. Install the Battery Eject Button into its hole in the bottom case. Push the Eject Button all the way in to engage its catch and prevent it from falling back out. Check to be sure the Eject Button and Eject Catch slide freely and operate correctly.
4. Replace the battery cover as described under "Battery Cover" on page 4-15.

Data Card Door

Removal

1. Open the door. This will expose the shaft on which the door pivots. Note the spring wrapped around the shaft.
2. Using a small flat bladed screwdriver, catch the right end of the pivot shaft and slide it toward the center, compressing the spring. When the spring is compressed enough, the pivot shaft will pop easily out of its hole in the bottom case.
3. Remove the door.

Replacement

1. The new door comes complete with the black latch, the pivot shaft and the spring already installed in the door.
2. Check to be sure the pivot holes in the case have not been damaged. If they have been, the Bottom Case Assembly must be replaced.
3. Insert one end of the pivot shaft into the hole on the defibrillator case. Compress both ends of the pivot shaft against the spring and snap the door into place.
4. Check to be sure the door moves freely, latches securely, and springs open when unlatched.

Labels

The labels used on the M3500B/M5500B are divided into 3 groups: the Case Label Set, the Branding Label Set, and the Speaker Label. Each set of labels is one sheet containing all the included labels.

The labels are adhesive-backed, and replacing a label consists of peeling up the old, cleaning the surface, and sticking down the new. See "Removing and Replacing Labels" on page 4-22.

Not shown here are the labels for the Manual Door; they are available only as part of the replacement Manual Door Assembly.

Label Descriptions

The following sections describe each of the label sets in more detail.

Case Label Set

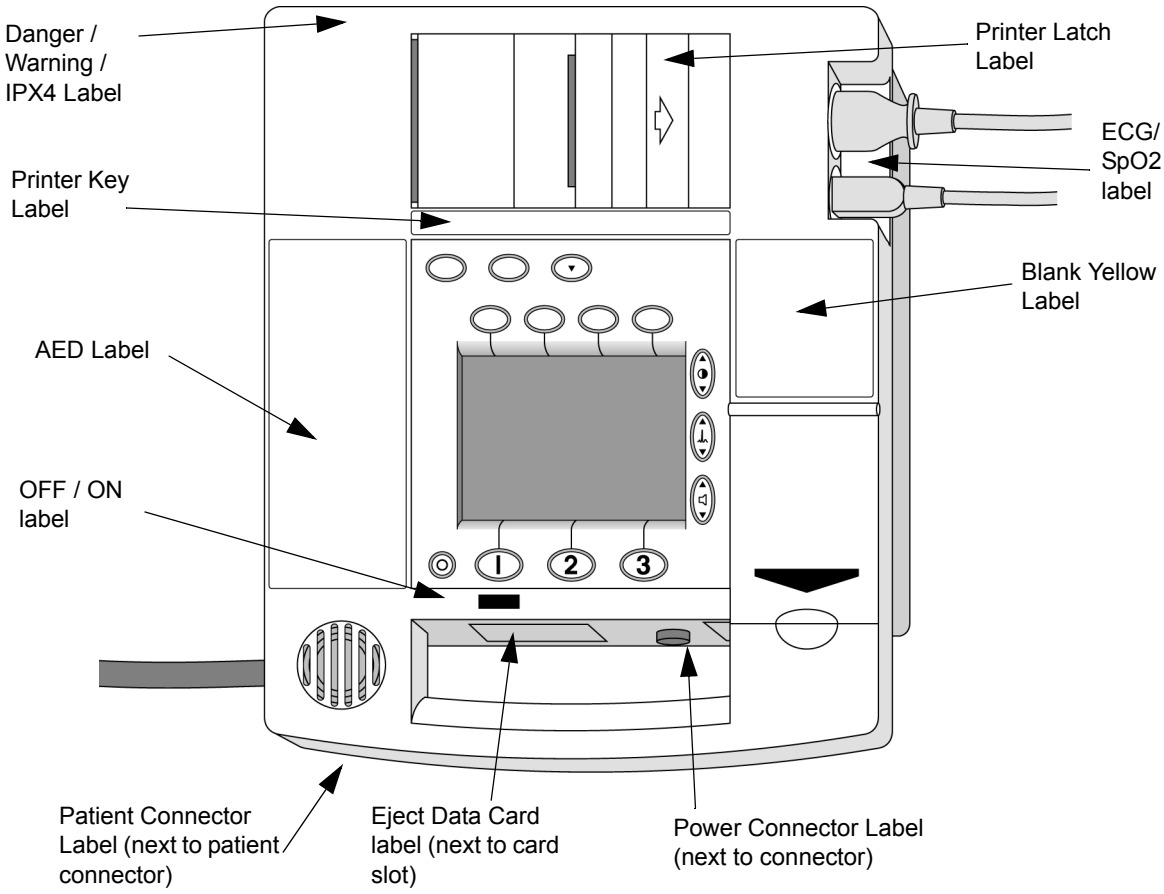
The case label set includes most of the labels on the top and bottom case, except those that vary with the brand under which the product is sold (Philips or Laerdal), and those that vary with product options (pacing, SpO_2). This set includes:

- AED Operation label
- Printer key label
- OFF / ON label
- DANGER / WARNING / IPX4 label
- Printer latch label (arrow)
- Power Connector label
- Patient Connector label
- ECG/SpO_2 Connectors label
- EJECT Data Card label
- Blank yellow label

See "Case Label Locations" on page 4-20 for correct placement.

The Case Label Set is available in all the supported languages (see Table 5-12 on page 5-14 for part numbers).

Figure 4-11 Case Label Locations



Branding Label Set

Branding labels include the Philips or Laerdal branding, and brand-specific product name information (2 labels, found on the unit's handle). They also include the Ambient Light Sensor cover. They are available in 3 types:

- Philips HeartStart XLT (worldwide) - M3500-69556.
- Laerdal Heartstart 4000 (North America) - M3500-69557.
- Laerdal Heartstart 4000 (outside of North America) - M3500-69558.

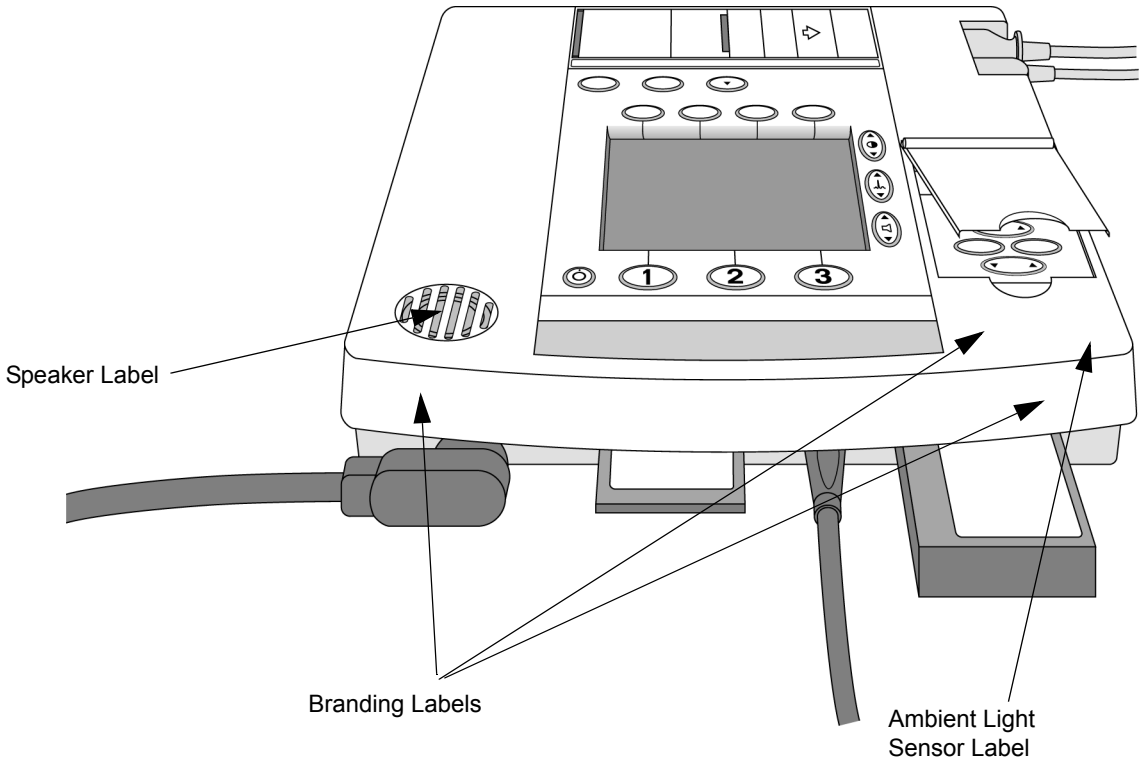
These do not have language localization.

Ambient Light Sensor Label

The Ambient Light Sensor allows the Display to automatically turn the back-light on and off depending on ambient light levels. The light sensor label (cover) seals the opening in the case through which light reaches the sensor. The cover is formed of a small clear circular area surrounded by a yellow rectangle.

The Light Sensor Label is included with the Branding Label Set.

Figure 4-12 Branding Label Locations



Speaker Label Set

The speaker label (cover) seals the speaker grille, and is designed to provide good sound transmission. It consists of a clear circular area surrounded by a yellow rectangle.

Removing and Replacing Labels

Removal

Using a sharp tool such as a utility knife, carefully pick up one corner of the damaged label and peel the entire label off the case. Be careful not to gouge the case.

Replacement

1. Clean off all adhesive residue from the case by rubbing the dry surface with your finger and 'rolling up' the adhesive residue. Solvents are ineffective, as is scraping with a tool.
2. Clean the surface with isopropyl alcohol. Allow it to dry.
3. Peel the new label off the backing material.
4. Starting with one straight edge, align the label carefully and roll it down slowly into place.
5. Press firmly all around the label, especially the edges, to adhere it into place.

Opening the Sealed Case

Opening the sealed case ***safely*** involves 3 steps, described in the sections called out below:

- "Discharging the Power Supply Capacitors" (page 4-23).
- "Separating the Case" (page 4-25).
- "Discharging the Defibrillator Capacitor" (page 4-27).

Discharging the Power Supply Capacitors

The steps that follow describe 2 methods of discharging the unit's power supply capacitors. Always employ the Primary Method, as it will work in most cases. If it does not, the Secondary Method should be used.

CAUTION

Always discharge the power supply capacitors before servicing the M3500B/M5500B.

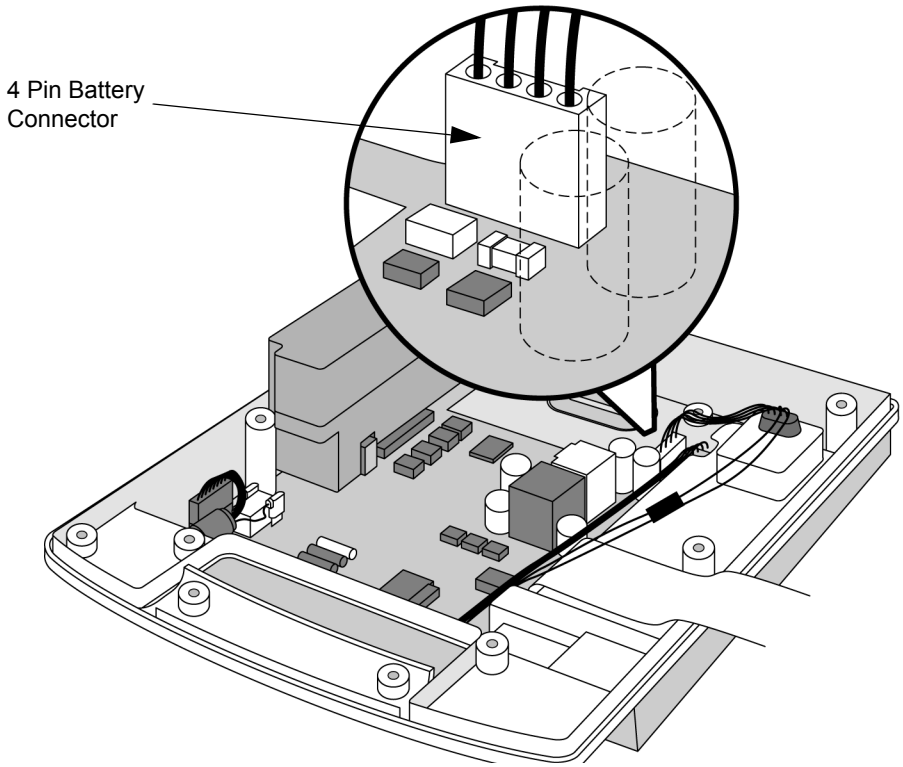
Primary Method

1. Disconnect the Power Module and remove the battery.
2. Turn the power on. You may hear a "click" from the speaker. If so, ***the power supply capacitors are now discharged.***
3. If you do not hear a click, use the Secondary Method.

Secondary Method:

1. Open the case as described under "Separating the Case" on page 4-25.
2. Discharge the defibrillator capacitor as described under "Discharging the Defibrillator Capacitor" on page 4-27.
3. Disconnect and remove the defibrillator capacitor as described in "Defibrillator Capacitor" on page 4-60. Leave the bottom piece of foam in place on the wires.
4. Unplug the 4 pin battery connector from the Power PCA. See Figure 4-13.
5. Discharge the power supply capacitors as follows:
   a. Using 2 clip leads, connect one clip lead to each end of one of the Disarm Resistors.
   b. Touch the other ends of the clip leads to the two middle pins of the battery connector on the Power PCA. Maintain this connection for at least 5 seconds. ***The power supply capacitors are now discharged.***
6. If the Disarm Pathway was found to be damaged in the earlier steps, repeat step 5 using the other Disarm Resistor.

Figure 4-13 Battery Connector Location



Separating the Case

WARNING

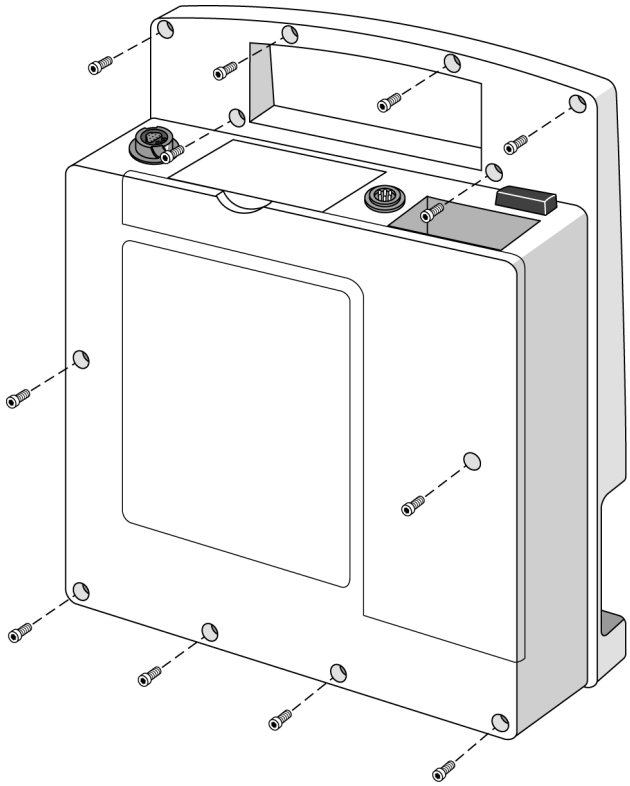
Dangerous voltages may be present on components and connections exposed during unit disassembly. Use extreme caution while the unit cover is removed.

CAUTION

Be sure to work in a static free environment. Use an electrostatic wrist band. The work surface and area surrounding it must be static free. Use an antistatic pad which is grounded per the manufacturer's instructions.

1. Remove the Data Card by pushing its Eject button and pulling the card out. Be sure the button is fully in - if it is left partially extended it can catch on the bottom case and break off.
2. Turn the unit upside down (display facing down) with the handle closest to you.
3. Remove the Battery Cover to gain access to the case screw inside the battery compartment. See "Battery Cover" on page 4-15.
4. Remove (6) T15 screws from the bottom of the case. See Figure 4-14, which shows the case standing up for clarity. The screws are size-coded - remove only the T15 size.
5. Remove (6) T15 screws from the handle. Leave the two halves of the case together.

Figure 4-14 Removing the Case Screws



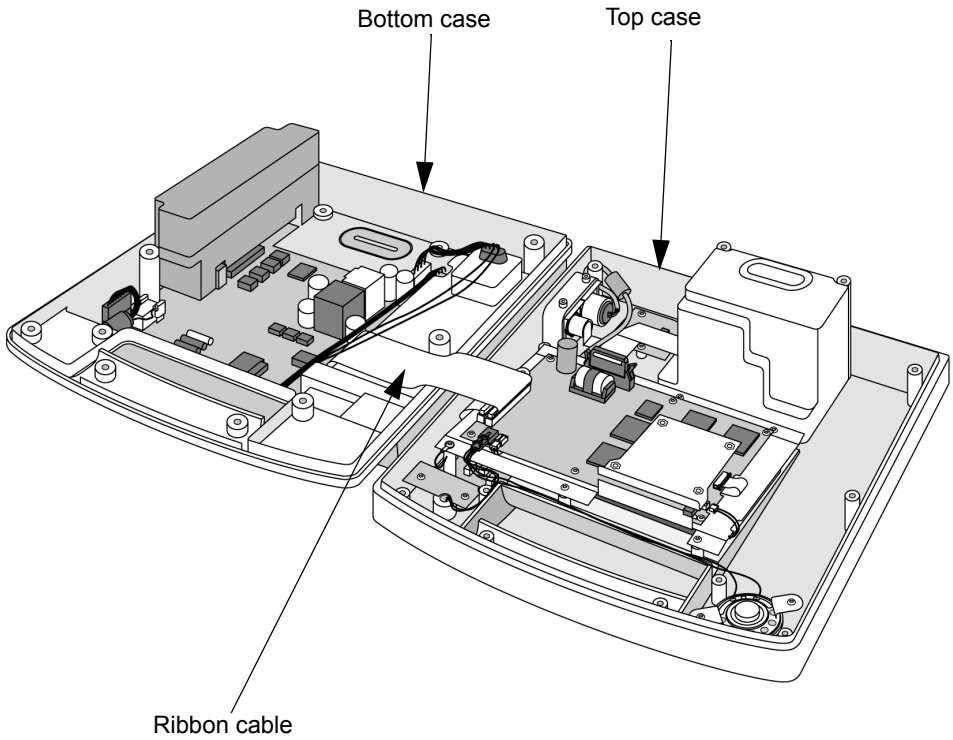
6. Turn the unit over so the display is facing up. Keep the handle closest to you. The case screws will fall out of their holes as you do this.

NOTE

To avoid losing any screws, apply tape over the screw holes before turning the case rightside up.

7. Open the case as follows:
   - **a.** Start opening the case at the back edge to break any adhesion along the gasket.
   - **b.** Pull the back of the top case up slightly.
   - **c.** Then pull up the front of the top case.
   - **d.** While pulling up, slide the top case away from you (toward the back of the unit) to avoid catching the Data Card Eject button on the bottom case.
8. Once the case halves are separated, pivot the top case to the right so it turns upside down. Lay the top case on the work surface upside down and next to the bottom case section. See Figure 4-15.
9. The two case halves will be joined by a ribbon cable. As you separate the case halves, take care that the ribbon cable is not damaged or pulled off its connectors in the top and bottom case.

Figure 4-15 Case Opened



Discharging the Defibrillator Capacitor

The steps that follow describe two methods of discharging the unit's Defibrillator Capacitor. Always employ the Primary Method, as it will work in most cases. If there are any doubts, the Secondary Method should also be used.

WARNING — *Always discharge the defibrillator capacitor before servicing this unit.*

WARNING — *To avoid completing a high voltage circuit, use only one hand to perform the following steps. Keep the other hand away from the unit at all times. Do not touch anything else but the parts described.*

1. Carefully lift up the defibrillator capacitor together with its two foam covers. Lift straight up, then roll the capacitor and its covers over to the side and lay them on their side on top of the Power PCA. Note the alignment of the foam pieces around the capacitor. Also note that both foam pieces are contoured to fit in the case only one way.
2. Inspect the Disarm Pathway, located under the Defibrillator Capacitor on the left side of the Power PCA. The Disarm Pathway consists of 2 large power resistors (Disarm Resistors), a red inductor, and the PCA traces that connect them. See Figure 4-16 on page 4-28. Look for signs of arcing or burning, damage to the resistors or inductor, blown traces on the Power PCA, etc.
   - If the Disarm Pathway is intact, refer to Figure 4-16 and use the Primary Method below to discharge the defibrillator capacitor.
   - If you see any burns or damage, the Disarm Pathway may not be intact. Use the Primary Method, then also use Secondary Method to discharge the defibrillator capacitor.

Primary Method

a. Using the High Voltage Discharge Tool, first touch one end of the tool's brass bar to the current sensing resistor (the small loop of flat metal).

b. Then pivot the brass bar so its other end contacts the exposed end of the disarm resistor.

c. Maintain contact at these two points for at least 5 seconds. ***The defibrillator capacitor is now discharged.***

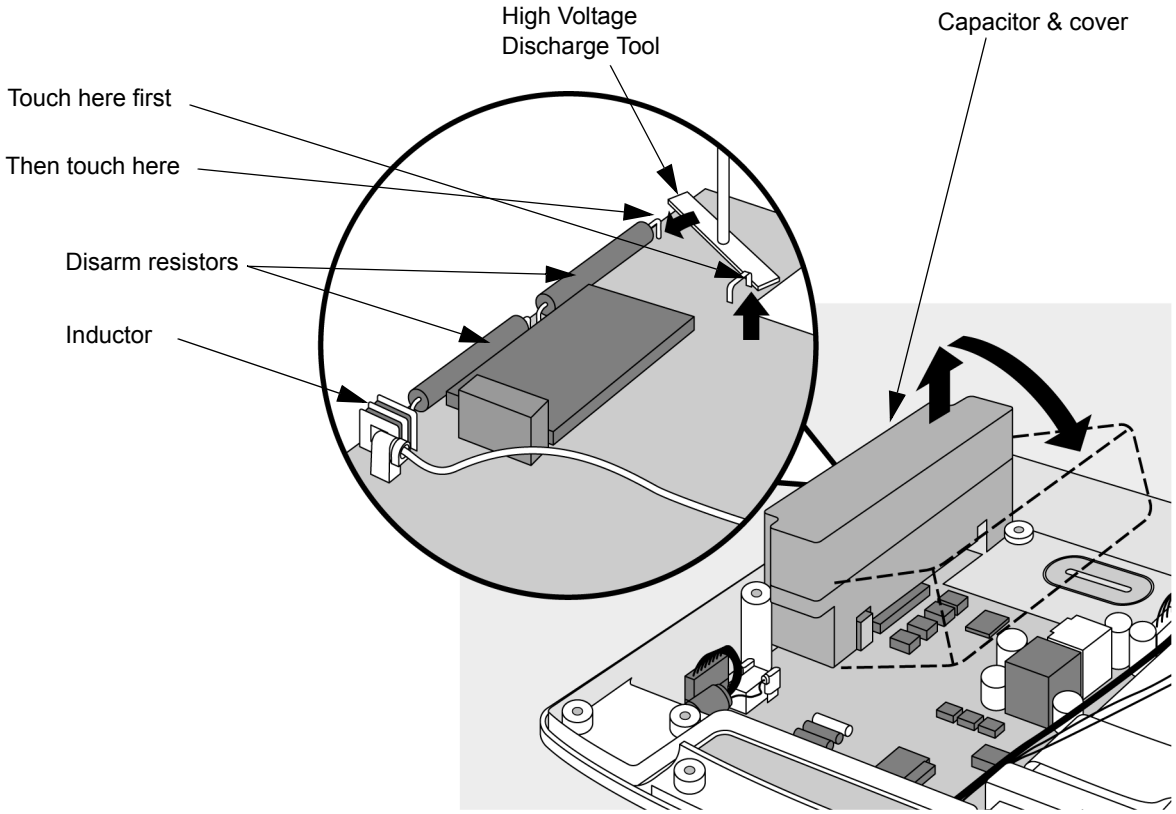
Secondary Method

a. Connect clip leads to each end of one of the Disarm Resistors.

b. Connect the clip leads directly to the spade terminals on the Power PCA where the Defibrillator Capacitor is connected. Maintain this connection for at least 5 seconds.

c. Repeat steps a and b using the other Disarm Resistor. ***The defibrillator capacitor is now discharged, even if one of the resistors is damaged.***

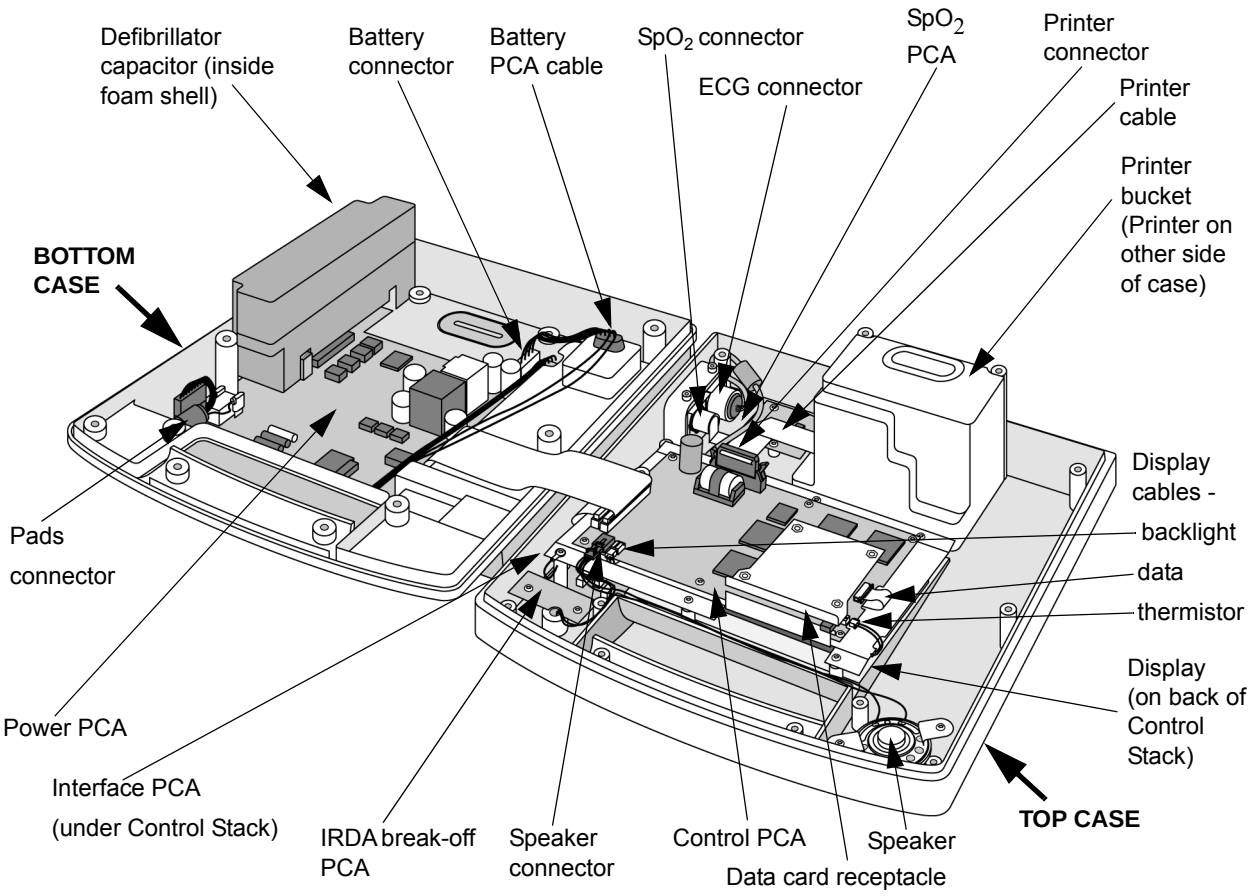
Figure 4-16 Discharging the Defibrillator Capacitor



Identifying Internal Subassemblies

Refer to Figure 4-17 to identify the internal subassemblies.

Figure 4-17 Internal Subassemblies



Top Case Assemblies

This section provides instructions for removing and replacing assemblies found in the top case.

Lithium Backup Battery

The Lithium Battery maintains the unit's stored information on the Control PCA when the main battery is removed or depleted. A cable tie wrap and a package of ProGold wipes are included in the Lithium Battery replacement kit. Make sure that you clean the contact clips and new battery terminals with a ProGold wipe and replace the cable tie wrap that holds the battery in place. See Table 5-5 on page 5-8 for the replacement kit part number.

Removal

1. If possible, save the customer's configuration onto a Data Card (or print the configuration) so the configuration can be restored after the repair is complete.
2. Using a pair of fine nose wire cutters, cut and remove the cable tie wrap that holds the battery in place. Remove the battery from the holder. See Figure 4-19.

Cleaning

a. Thouroughly clean the contact clips and new battery terminals with a ProGold wipe.

Replacement

CAUTION

Be sure to install the new battery with the correct orientation. Follow the polarity markings on the bottom of battery holder (under the battery).

1. Install the new Lithium battery. Secure it in place with a cable tie wrap. Pre-bend the tie wrap before sliding it under the battery holder from the front - this will allow it to slide up alongside the printer connector as it comes out on the other side. See Figure 4-19.
2. Use the Language Support Tool to restore the unit's serial number and to select whether SpO_2 hardware is installed or not. See "The Language Support Tool" on page 4-67.
3. Enter Configuration Mode and reload the customer's configuration from the data card, or reconfigure the unit. See "Configuration Mode" on page 2-10.
4. Perform Performance Verification Testing as described in "Performance Verification and Safety Tests" starting on page 2-1.

Disconnecting the Control PCA

These instructions cover how to disconnect the Control PCA - from the rest of the unit, and from the display. These procedures are often needed when removing and replacing other assemblies.

From the Rest of the Unit

Disconnect the 4 cables that connect the Control PCA to the rest of the unit. See Figure 4-18 on page 4-32.

1. Disconnect the two large ribbon cables on the left side of the Control PCA (1 connects to the Power PCA, 1 to the Interface PCA). Both of these require removal of metal bails (retainer clips) over their tops. Take care to not bend the bails.
2. Disconnect the small ribbon cable at the rear of the PCA (connects to the printer). This requires releasing latches on the ends of connector - push the latches out and down to release them.
3. Disconnect the small 2-wire speaker connector at the edge of the PCA. This connector has a latch on the top - push down on the latch to release it and wiggle the connector side to side to pull it out.

From the Display

Also referring to Figure 4-18 on page 4-32, disconnect the 3 cables that connect the Control PCA to the Display.

1. Disconnect the flex circuit on the right side of the Control PCA (the Display Data Cable). Pull out the latches on the ends of connector to release it before pulling on the flex.
2. Disconnect the white connector next to it (the display thermistor cable). This connector has a tiny latch - using a small flat blade screwdriver, push down in the slot that runs across the receptacle and push the plug out of the receptacle.
3. Disconnect the small 2-wire connector (the display backlight cable) on the edge of the Control PCA nearest the handle, next to the speaker connector. It also has a tiny latch - push in the center slot with small flat bladed screwdriver using the corner of the blade, and push connector out of receptacle.

Reconnecting the Control PCA

The following steps describe how to reconnect the Control PCA - to the display, and to the rest of the unit. These procedures are often needed when removing and replacing other assemblies.

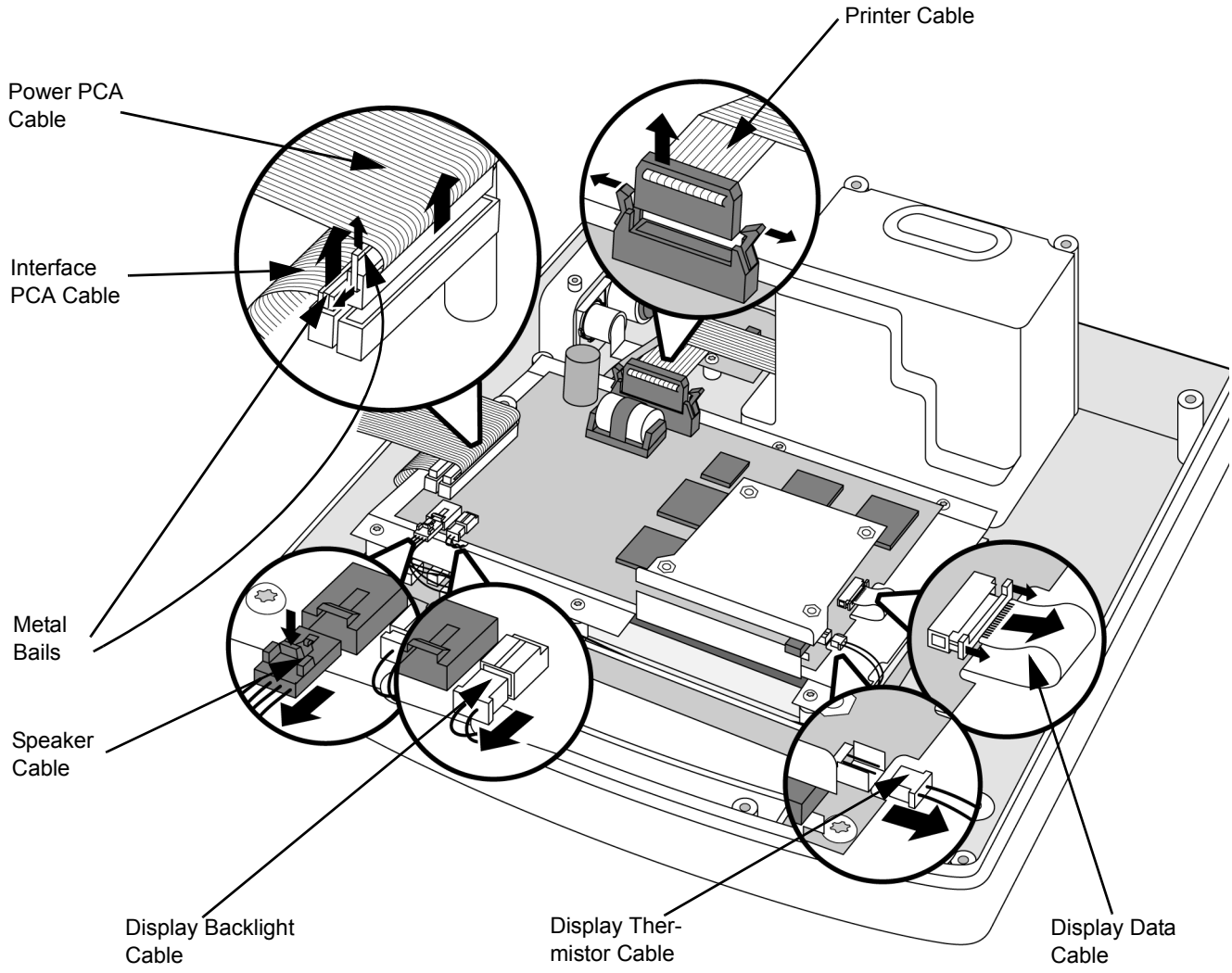
To the Display

1. Connect the display backlight cable to the Control PCA.
2. Connect the display thermistor cable.
3. Insert the display data cable into its connector and latch into place.

To the Rest of the Unit

1. Connect the speaker cable to the Control PCA.
2. Connect the printer cable.
3. Connect the 2 large ribbon cables - 1 from the Power PCA, 1 from the Interface PCA. Be sure to replace the 2 metal bails on the 2 large ribbon connectors. If the clips have become loose or are missing, replace them.

Figure 4-18 Control PCA Connections



Control Stack

The Control Stack consists of the Control PCA, the metal shield plate to which that mounts, and the Display, which is mounted on the back of the shield plate. The steps below describe how to remove and replace the Control Stack. This procedure is often needed when replacing other assemblies.

Removal

1. Disconnect the Control PCA from the rest of the unit. See "Disconnecting the Control PCA" on page 4-31.
2. Remove the 5 T10 screws around the edge of the metal shield plate and remove the Control Stack. See Figure 4-19. Lift it straight up out of the case and lay it down, display side up, on a soft static-protected surface.

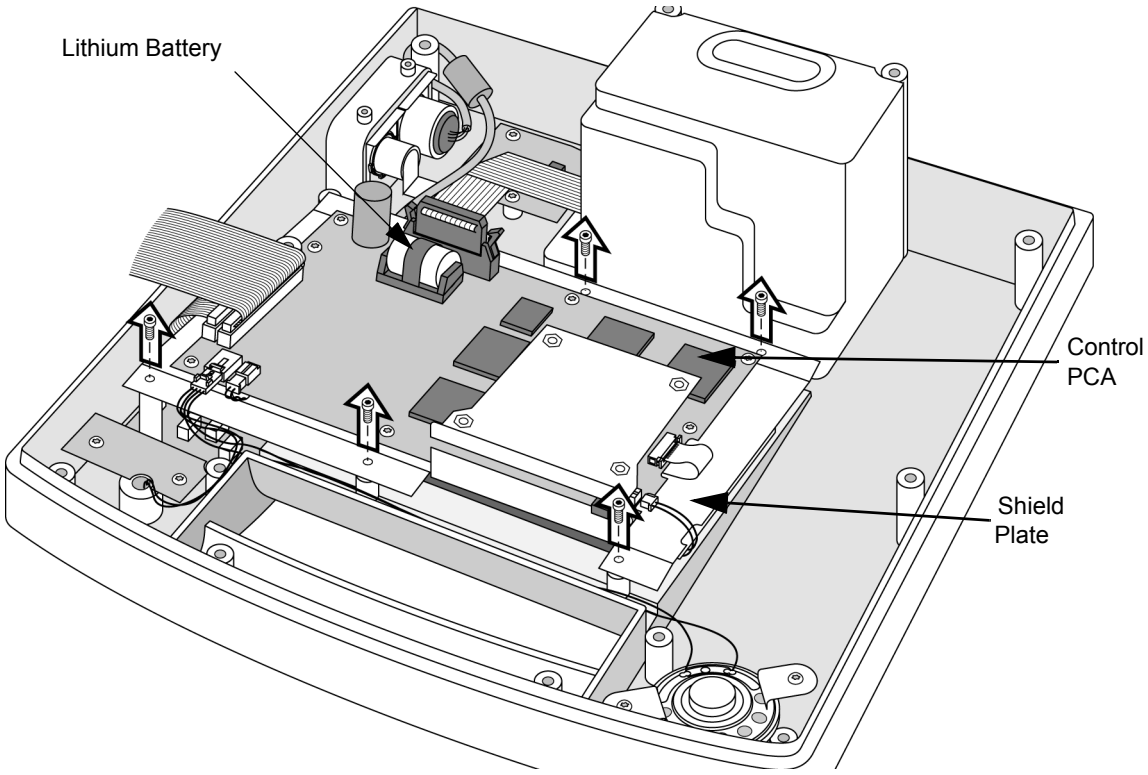
CAUTION

Removing the Control Stack exposes the back side of the Display Window. Do not touch this side of the Display Window - fingerprints, etc. are very difficult to remove from its specially coated surface.

Replacement

1. Put the Control Stack back in place in the case.
2. Install the 5 screws in the shield plate. See Figure 4-19.
3. Reconnect the Control PCA to the rest of the unit (see "Reconnecting the Control PCA" on page 4-31).

Figure 4-19 Removing the Control Stack



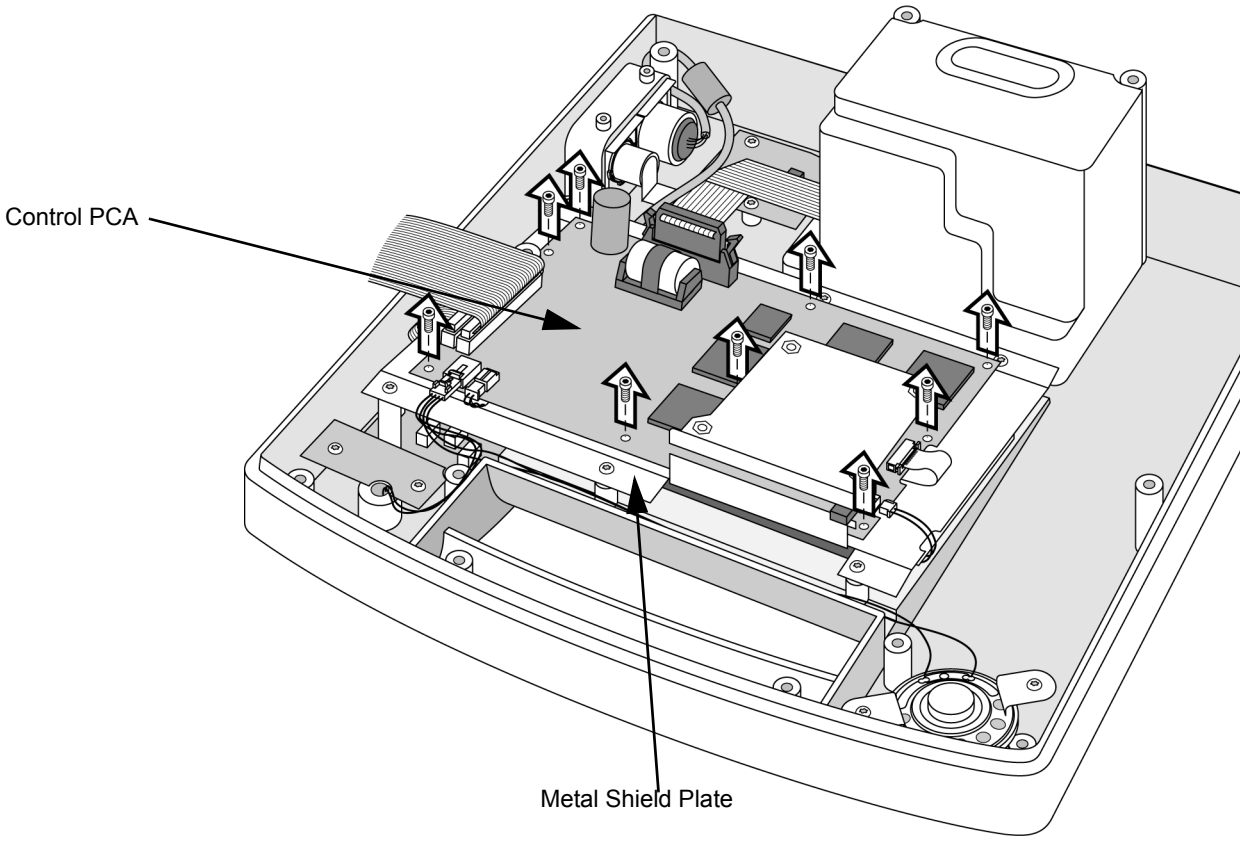
Control PCA

The steps below describe how to remove and replace the Control PCA. The Control PCA contains the unit's operating software, including the data for the voice prompts. All Control PCAs are American English, part number M3500-68100. Installing a new Control PCA requires the use of the Language Support Tool to set the Control PCA to the corrrect language. See Table 5-2 on page 5-7 for part numbers.

Removal

1. If possible, save the customer's configuration onto a Data Card (or print the configuration) so the configuration can be restored after the repair is complete.
2. Disconnect the Control PCA from the rest of the unit and from the display as described in "Disconnecting the Control PCA" on page 4-31.
3. Remove the 8 screws around edges of the Control PCA - not the screws in the metal shield. See Figure 4-20 on page 4-35.
4. Remove the 1 screw near the center of the PCA. Be careful not to damage any nearby components or traces. See Figure 4-20 on page 4-35.
5. Slide the Control PCA toward the rear while lifting it off the metal shield plate. This will help the Eject button clear its hole in the black plastic shield surrounding the Data Card receptacle. If the black plastic shield is damaged, remove it; otherwise leave it in place.
6. Leave the lithium backup battery in place when returning the PCA for repair. This will help preserve information for factory troubleshooting.

Figure 4-20 Control PCA Screws



Replacement

1. Slide the new tie wrap under the battery holder.
2. Place the Control PCA in its place on the metal shield. Replace the 8 screws around the edges of the PCA. Replace the 1 screw near the center of the PCA. If the black plastic shield around the Data Card receptacle is damaged, replace it with the one that came with the PCA.
3. Install the new Lithium battery from the kit. Secure it in place with the cable tie wrap.
4. Wrap the tie wrap around the battery and secure it to the battery holder.
5. Reconnect the Control PCA to the Display and to the rest of the unit (see "Reconnecting the Control PCA" on page 4-31. The order of making connections does not matter. Be sure to replace the 2 metal bails on the 2 large ribbon connectors. If the clips have become loose or are missing, use the new bails included with the PCA.
6. Use the Language Support Tool to set the correct language, restore the unit's serial number, and to select whether SpO_2 hardware is installed or not. See "The Language Support Tool" on page 4-67.

7. Reload the customer’s configuration, or reconfigure via configuration menus as needed.
8. Perform Performance Verification Testing as described in "Performance Verification and Safety Tests" starting on page 2-1.

LCD Display Assembly

The LCD is under the Control PCA, on the other side of the metal shield plate. The Control stack should be removed, then flipped over to access the LCD.

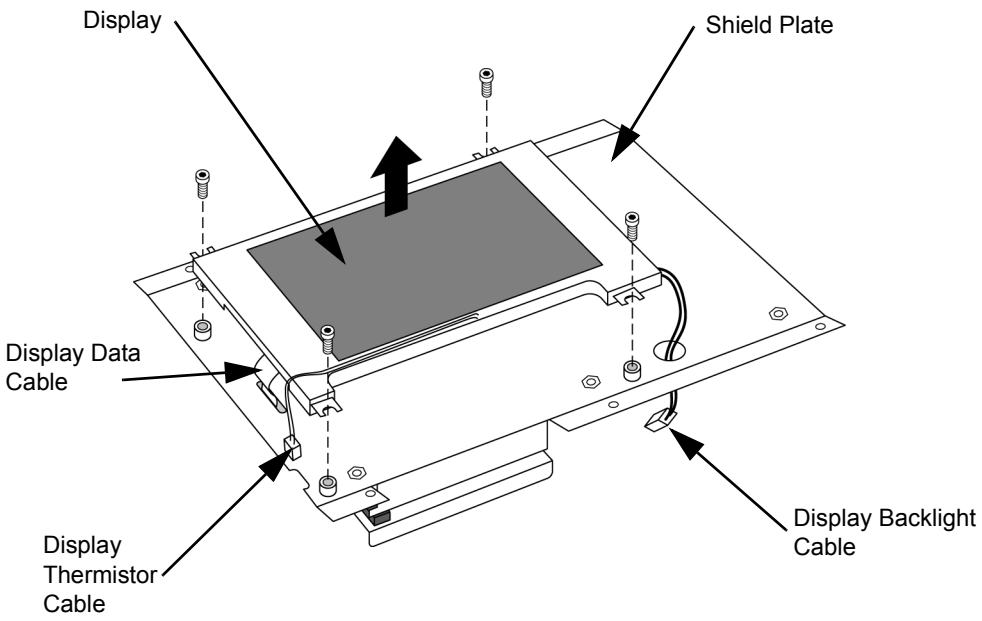
CAUTION — DO NOT touch the back side (interior of case side) of the display window.

CAUTION — See the notes on handling and connecting flex circuits ("Servicing Notes" on page 4-1).

Removal

1. Disconnect and remove the Control Stack. See "Control Stack" on page 4-33.
2. Remove the 4 screws from the Display. Lift it off the shield plate carefully, sliding the flex ribbon out through its slot in the shield plate as shown in Figure 4-21.

Figure 4-21 Removing the Display



Replacement

1. Connect the flex circuit that came with the new display to the new display.
2. Slide the flex ribbon in through its slot in the shield plate and up to the Control PCA.
3. Put display in place against the shield plate and install the 4 screws.
4. Replace and reconnect the Control Stack. See "Control Stack" on page 4-33.

SpO_2 PCA

The SpO_2 PCA is located next to the ECG and SpO_2 connectors.

Removal

1. Disconnect and remove the ECG connector. See "ECG Connector" on page 4-40.
2. Disconnect and remove the SpO_2 connector. See "SpO_2 Connector" on page 4-42.
3. Note the orientation and placement of the flex circuit from the SpO_2 PCA to the Interface PCA. Disconnect this flex circuit at both ends. These connectors have a sliding bar latch - slide out toward the edge of the PCA to release, then pull out the flex.
4. Remove the SpO_2 PCA and discard the flex circuit to the Interface PCA.

Figure 4-22 Removing the Screws - SpO_2 PCA

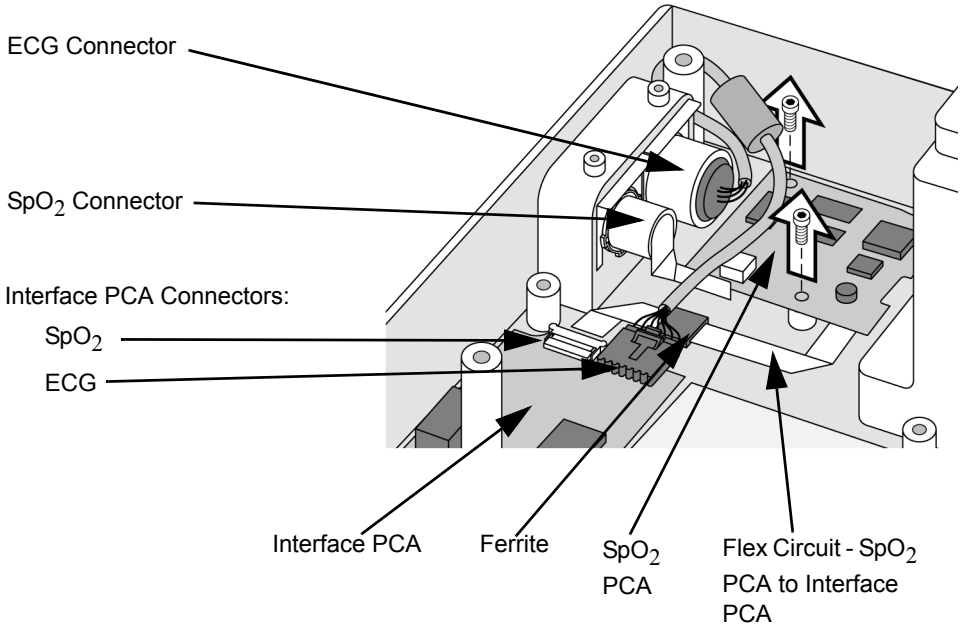
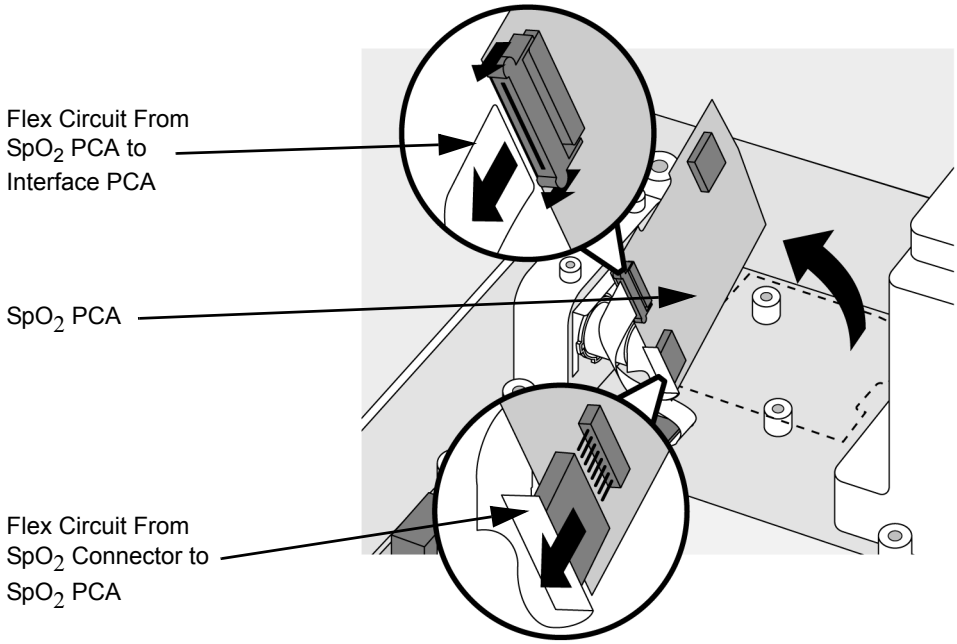


Figure 4-23 Disconnecting the SpO_2 PCA



Replacement

1. Using isopropyl alcohol, clean the case bottom where the ferrite will be located (next to the end of the Interface PCA) and allow it to dry.
2. Gently unbend one end of the new flex circuit and slip the new ferrite on. Then gently bend the flex circuit back to its original position. Do not kink it sharply.
3. Connect one end of this flex circuit to the Interface PCA. Note the correct orientation as shown in Figure 4-22 - the short tail connects to the Interface PCA, and the long tail connects to the SpO_2 PCA .
4. Attach the adhesive patch onto the bottom of the ferrite.
5. Connect the other end of the flex circuit to the SpO_2 PCA.
6. Replace the SpO_2 connector and connect it to the SpO_2 PCA. See "SpO_2 Connector" on page 4-42.
7. Using the adhesive patch, secure the flex circuit and its ferrite in position against the bottom case.
8. Replace and reconnect the ECG connector as described in "ECG Connector" on page 4-40.

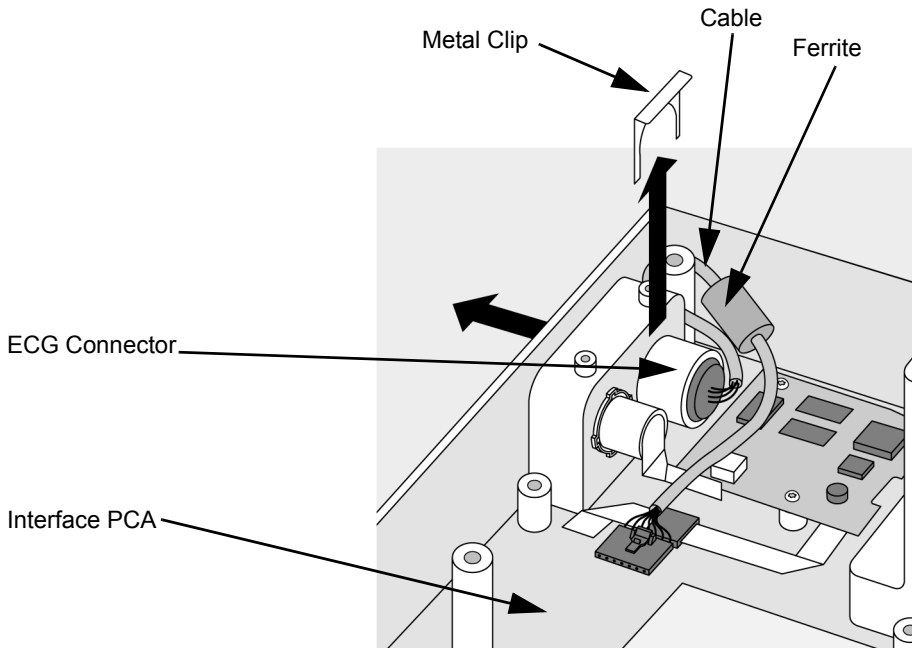
ECG Connector

The ECG connector is located in the corner of the top case, next to the SpO_2 connector.

Removal

1. Disconnect and remove the Control Stack. See "Control Stack" on page 4-33.
2. Remove the plastic insulating shield over the SpO_2 and Interface PCAs. Remove the tape that secures the shield to the metal clips around the SpO_2 and ECG connectors and pull the shield straight up.
3. Referring to Figure 4-22, disconnect the cable from the ECG connector to the Interface PCA at the Interface PCA. Press the latch on top of the connector and pull straight out. Swing the cable up out of way and lift it off the case post.
4. Release the locking tabs on the metal clip around the ECG connector using a small flat-bladed screwdriver. Pull up and remove the metal clip.
5. Slide the connector, cable, gasket and ferrite out through the hole in the case.

Figure 4-24 Removing the ECG Connector



Replacement

1. Using the new gasket that came with the connector, install the gasket in place on the connector. Slide the cable and ferrite back through the hole in the case.
2. Align connector and gasket with notches in case and insert in hole. Make sure the gasket is in place properly, between the connector and the outside of the case.
3. Press in firmly on the connector to compress the gasket. Slide the metal retainer clip into place behind the 2 plastic lugs on the connector, being sure it locks into place. Use the new retainer clip that came with the connector.
4. Loop the cable around the case post and secure with the cable tie provided.
5. Connect the ECG connector to the Interface PCA, being sure the ECG cable is above the SpO_2 flex circuit.
6. Replace the plastic insulating shield over the SpO_2 and Interface PCAs. Align the hole in its wide end over the case post. Slide the left edge of its narrow end under the lips on the metal retaining clips on the ECG and SpO_2 connectors. Secure the shield to the clips with the original tape, or use other plastic electrical tape.
7. Replace and reconnect the Control Stack. See "Control Stack" on page 4-33.

SpO_2 Connector

The SpO_2 Connector is located in the corner of the top case, next to the ECG Connector.

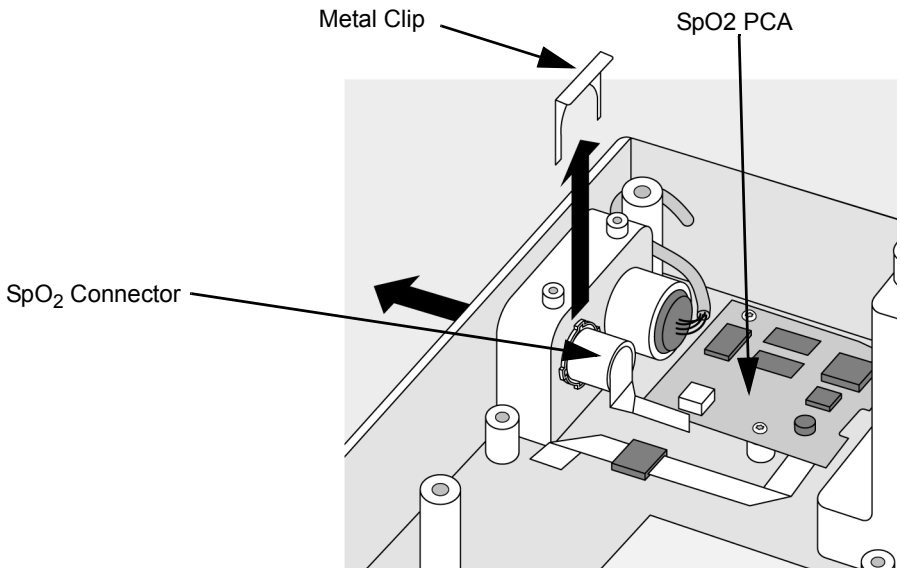
CAUTION

See cautions regarding handling and connection of flex circuits on page 4-1.

Removal

1. Disconnect and remove the ECG Connector. See "ECG Connector" on page 4-40.
2. Remove the 2 screws from the SpO_2 PCA. See Figure 4-22.
3. Lift up the PCA gently. Pivot to make the underside visible as shown in Figure 4-23.
4. Note the orientation and placement of the flex circuit between the SpO_2 connector and the SpO_2 PCA. Disconnect it at the SpO_2 PCA. There is no latch - just pull it straight out.
5. Leave the flex circuit from the SpO_2 PCA to the Interface PCA connected.
6. Release the locking tabs on the metal clip around the SpO_2 connector using a small flat-bladed screwdriver. Pull up and remove the metal clip. See Figure 4-25.
7. Slide the connector, gasket, and flex circuit out through the hole in the case.

Figure 4-25 Removing the SpO_2 Connector



Replacement

1. Using the new gasket that came with the connector, install the gasket in place on the new connector. Slide the connector and flex back through the hole in the case.
2. Lift up the SpO_2 PCA. Pivot to make the underside visible as shown in Figure 4-23.
3. Connect the flex circuit from the SpO_2 connector to the SpO_2 PCA. Line it up carefully, avoiding excessive twisting. There is no latch - just push straight in. See Figure 4-23 on page 4-39.
4. Pivot the PCA down into position. Install the (2) T10 screws (see Figure 4-23).
5. Align the connector and gasket with the notches in case and insert them in the hole. Make sure the gasket is in place properly, between the connector and the outside of the case.
6. Press in firmly on the connector to compress the gasket. Slide the metal retainer clip into place behind the 2 plastic lugs on the connector, being sure it locks into place. Use the new retainer clip that came with the connector.
7. Restore the flex circuit to the Interface PCA back to its original position against the bottom case. Secure with adhesive patch.
8. Replace and reconnect the ECG connector as described in "ECG Connector" on page 4-40.

Manual Keypad Assembly

Should the Manual Keypad sustain a puncture or tear, it must be replaced in order for the unit to be water resistant. The Manual Keypad assembly consists of a heavy rubber overlay, and under that the membrane switches themselves. Both parts are adhesive-backed, and replacing them consists of peeling up the old, cleaning the surface, and sticking down the new.

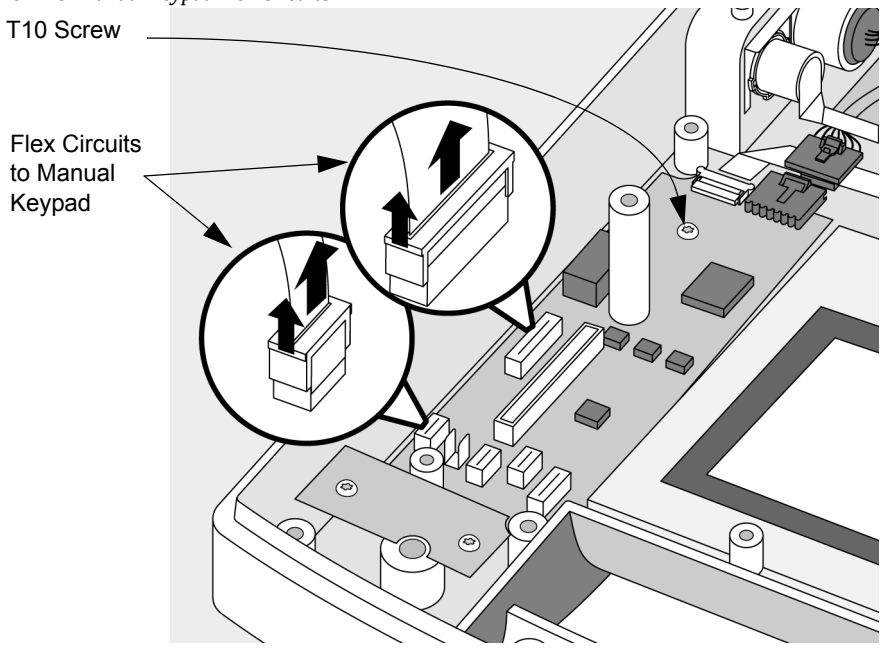
CAUTION

See cautions regarding handling and connection of flex circuits on page 4-1.

Removal

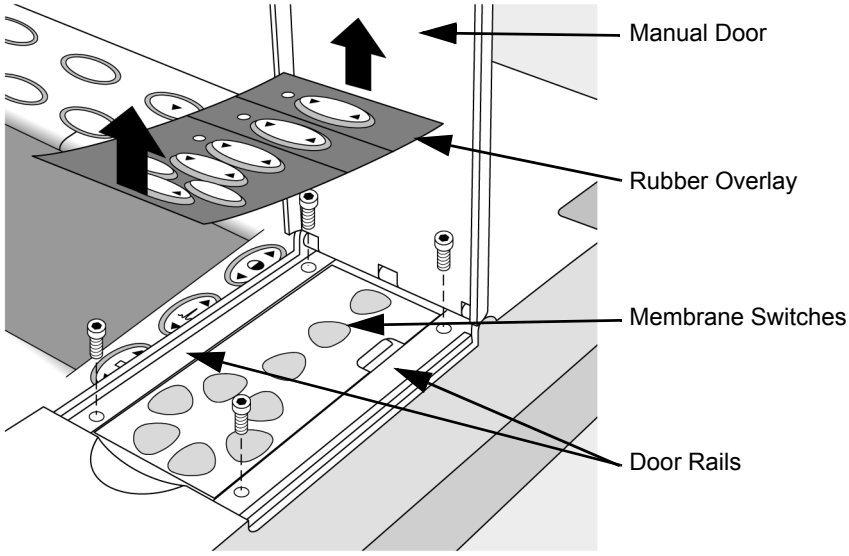
1. Disconnect and remove the Control Stack. See "Control Stack" on page 4-33.
2. Remove the plastic insulating shield over the SpO_2 and Interface PCAs. Remove the tape that secures the shield to the metal clips around the SpO_2 and ECG connectors and pull the shield straight up.
3. Referring to Figure 4-26, disconnect the 2 flex circuits from the Manual keypad to the Interface PCA at the Interface PCA. Pull up on the top edge of the white connector to unlatch the ZIF, then gently slide out the flex. Disconnect only those 2, and leave all other connections to the Interface PCA intact.

Figure 4-26 Manual Keypad Flex Circuits



4. Flip the top case over rightside up and place it on the bottom case for support.
5. Remove the Manual Door. See "Manual Door" on page 4-4.
6. Remove the rubber overlay and the membrane switches as follows:
   a. Using a sharp tool such as a utility knife, carefully pick up one corner of the rubber overlay and peel the entire overlay off the case. Be careful not to gouge the case. See Figure 4-27.

Figure 4-27 Removing the Rubber Overlay



b. Remove the 4 Torx #10 screws now visible around the edge of the keypad. See Figure 4-27.

c. Remove the Manual Door shaft and rails. Note the orientation of the shaft between the rails. If at all possible keep the shaft captured between the rails.

d. Using a sharp tool such as a utility knife, carefully pick up one corner of the membrane switches and peel the entire switch assembly off the case. Be careful not to gouge the case. The membrane switches will likely peel apart into several layers - be sure to remove all layers.

e. Slide the 2 flex circuit tails out of the slot in the case.

7. Turn the top case over and loosen the Interface PCA (do not remove it) as follows:

a. Remove (1) T10 screw from the Interface PCA (near the ECG and SpO_2 connections). See Figure 4-26 on page 4-44.

b. Release the retaining clip at the end of the PCA nearest the Ambient Light Sensor. Use a small flat bladed screwdriver to gently pry between the clip and the PCA, levering the PCA up and free of the retaining clip. Simply leave the PCA loose in position.

Replacement

1. Prepare the case as follows:

   a. Clean off all adhesive residue from the case and manual door rails by rubbing the dry surface with your finger and 'rolling up' the adhesive. Lightly scoring the adhesive with a rounded tool will aid removal. Solvents are ineffective, as is scraping with a sharp tool.

NOTE

The adhesive used is very difficult to remove. Take your time and do a thorough job to ensure a correct seal with the new switches and overlay.

   b. Clean surfaces thoroughly with isopropyl alcohol (an alcohol wipe is fine). Allow to dry completely.

2. Install the new membrane switches as follows:

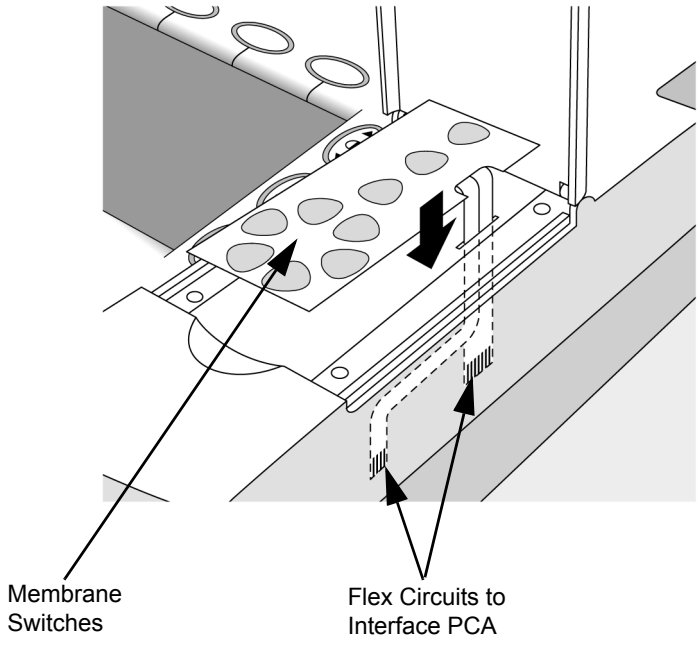
   a. Feed the 2 flex circuits down through the slot in the case as shown in Figure 4-28. Slide the smaller one in first, then the larger one. Feed them around the side of the Interface PCA nearest their connectors.

   b. Peel the backing material off the new switches. Handle very carefully and touch the adhesive as little as possible.

   c. Starting with the top edge, align the switches very carefully in their recess in the case and roll them down slowly into place. Be careful not to kink the flex circuit tails as you slide them into their slot under the switches.

   d. Press firmly all over, especially the edges, to adhere the new switches into place and seal the case opening.

Figure 4-28 Installing the Membrane Switches



3. Replace and reconnect the Interface PCA as follows:
   a. Replace the Interface PCA into position, snapping it under the retainer clip and replacing its screw. Visually check the connections to the PCA to be sure none have loosened and that all are properly aligned. See Figure 4-29 on page 4-51.
   b. Replace (1) T10 screw in the Interface PCA and tighten.
   c. Replace the Manual Door shaft and rails into position. Install the 4 screws from the top side of the case into the Interface PCA and tighten.
   d. Carefully reconnect the 2 flex circuits to the Interface PCA. Do not twist or kink them.
4. Do not install the rubber overlay on the switches at this time.
5. Reconnect the rest of the unit as follows:
   a. Replace the plastic insulating shield over the SpO_2 and Interface PCAs. Align the hole in its wide end over the case post. Slide the left edge of its narrow end under the lips on the metal retaining clips on the ECG and SpO_2 connectors. Secure the shield to the clips with the original tape, or use other plastic electrical tape.
   b. Replace and reconnect the Control Stack. See "Control Stack" on page 4-33.
   c. Restore any other connections, including replacing the defibrillator capacitor and plugging the battery connector back onto the Power PCA if needed.
6. Check the membrane switches as follows:
   a. Close the case but do not install any screws at this time.
   b. Replace the battery, and enter Diagnostic Mode (see "Diagnostic Tests" on page 2-16).
   c. Perform the Controls Test and check each of the Manual/Pacing keys (see "To check the Controls (keys):" on page 2-19).

      If there are any failures, remove the battery and discharge the Power Supply Capacitors. Then carefully reseat each of the Manual Key flex circuits into their connectors on the Interface PCA and try again.
   d. When the keys are known to be working, turn the power off and proceed with the installation.
7. Install the rubber overlay as follows:
   a. Clean the surfaces of the case and membrane switches (NOT the rubber overlay) thoroughly with isopropyl alcohol (an alcohol wipe is fine). Allow to dry completely.

b. Peel the backing material off the rubber overlay. Handle carefully and touch the adhesive as little as possible.

c. Starting with the top edge, align the overlay exactly and roll it down slowly into place.

d. Press firmly all over, especially the edges, to adhere the new overlay into place.

8. Replace the Manual Door.
9. Be sure to specifically check the operation of each of the keys during Performance Verification by performing a Controls Test (see "To check the Controls (keys):" on page 2-19).

Interface PCA

The Interface PCA is located in the top case, under the Control Stack.

NOTE

When replacing the Interface PCA, the manual keypad MUST also be replaced. The screws which attach the Interface PCA to the case are UNDER the manual key overlay.

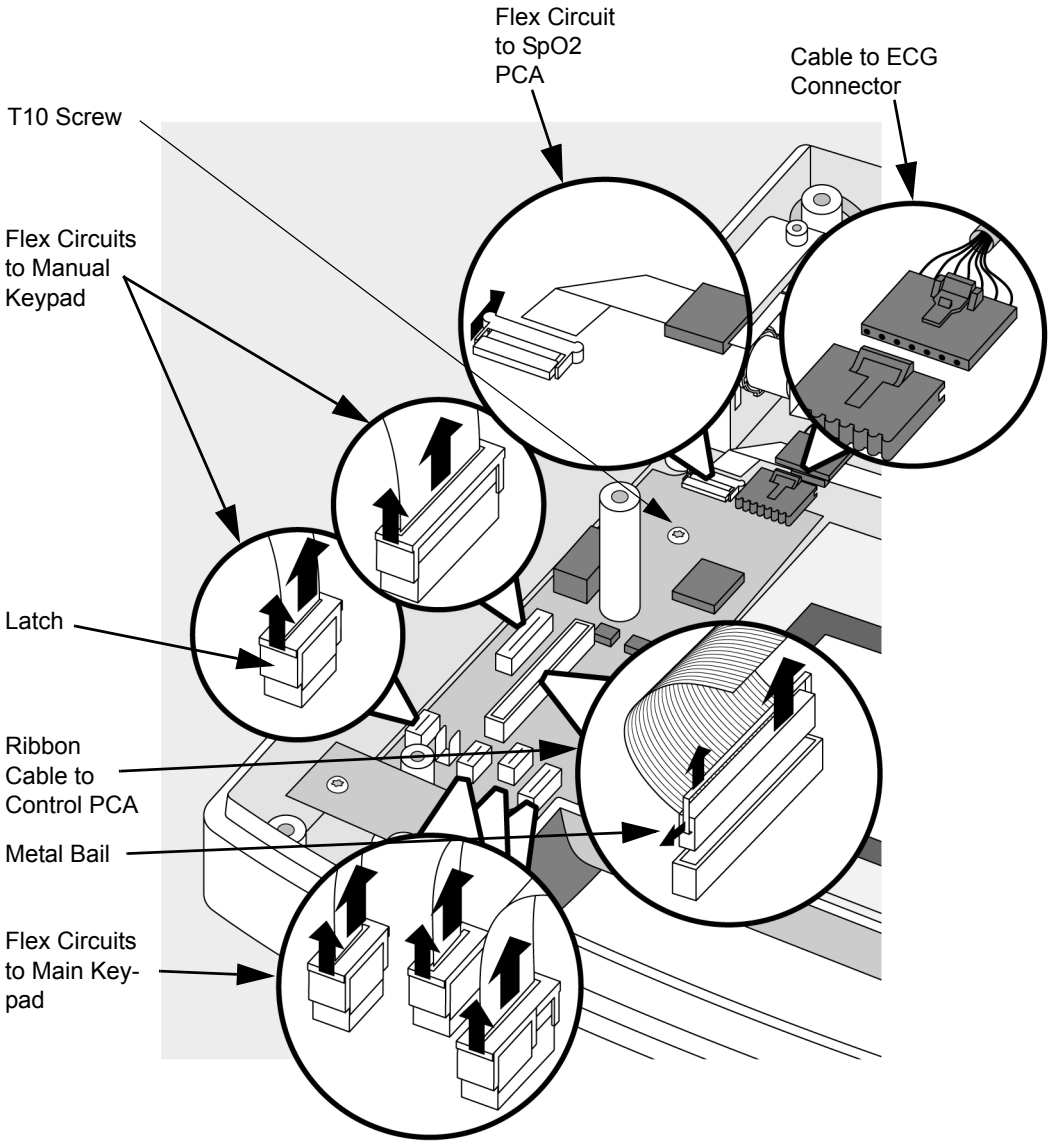
CAUTION

See cautions regarding handling and connection of flex circuits on page 4-1.

Removal

1. Disconnect and remove the Control Stack. See "Control Stack" on page 4-33.
2. Remove the plastic insulating shield over the SpO_2 and Interface PCAs. Remove the tape that secures the shield to the metal clips around the SpO_2 and ECG connectors and pull the shield straight up.
3. Disconnect the Interface PCA as follows:
   a. Referring to Figure 4-29, disconnect the cable from the ECG connector to the Interface PCA at the Interface PCA. Press the latch on top of the connector and pull straight out. Swing the cable up out of way.

Figure 4-29 Disconnecting the Interface PCA



b. Carefully disconnect the flex circuit from the SpO_2 PCA to the Interface PCA at the Interface PCA. This connector has a sliding bar latch - slide out toward edge of PCA to release, then gently pull out flex as shown in Figure 4-29.

c. Disconnect the large ribbon cable from the Interface PCA to the Control PCA at the Interface PCA. Remove the metal retaining clip on the top of the connector and pull the connector straight up.

d. Disconnect the 2 flex circuits from the Manual keypad to Interface PCA at Interface PCA. Pull up on top edge of white connector to unlatch ZIF, then gently slide out flex.

e. Likewise disconnect the 3 flex circuits from the Main keypad to the Interface PCA.

4. Flip the top case over rightside up and place it on the bottom case for support.
5. Remove the Manual Door. See "Manual Door" on page 4-4.
6. Remove the Manual rubber overlay and the membrane switches as follows:

   a. Using a sharp tool such as a utility knife, carefully pick up one corner of the rubber overlay and peel the entire overlay off the case. Be careful not to gouge the case.

   b. Remove the 4 Torx #10 screws now visible around the edge of the keypad. See Figure 4-27.

   c. Remove the Manual Door shaft and rails. Note the orientation of the shaft between the rails. If at all possible keep the shaft captured between the rails.

   d. Using a sharp tool such as a utility knife, carefully pick up one corner of the membrane switches and peel the entire switch assembly off the case. Be careful not to gouge the case. The membrane switches will likely peel apart into several layers - be sure to remove all layers.

7. Turn the top case over and remove the Interface PCA

   a. Remove 2 screws from IRDA PCA. Remove 1 screw from Interface PCA.

   b. Release retaining clip at end of PCA nearest the IRDA PCA. Use a small flat bladed screwdriver to gently pry between the clip and the PCA, levering the PCA up and free of the retaining clip.

   c. IRDA PCA will remain attached to Interface PCA. Do not attempt to separate them.

Replacement

1. Prepare the case as follows:

   a. Clean off all adhesive residue from the case and manual door rails by rubbing the dry surface with your finger and 'rolling up' the adhesive. Lightly scoring the adhesive with a rounded tool will aid removal. Solvents are ineffective, as is scraping with a sharp tool.

NOTE

The adhesive used is very difficult to remove. Take your time and do a thorough job to ensure a correct seal with the new switches and overlay.

   b. Clean surfaces thoroughly with isopropyl alcohol (an alcohol wipe is fine). Allow to dry completely.

2. Install the new membrane switches as follows:

a. Feed the 2 flex circuits down through the slot in the case as shown in Figure 4-28. Slide the smaller one in first, then the larger one.

b. Peel the backing material off the new switches. Handle very carefully and touch the adhesive as little as possible.

c. Starting with the top edge, align the switches very carefully in their recess in the case and roll them down slowly into place. Be careful not to kink the flex circuit tails as you slide them into their slot under the switches.

d. Press firmly all over, especially the edges, to adhere the new switches into place and seal the opening in the case.

3. Do not install the rubber overlay on the switches at this time.
4. Replace and reconnect the Interface PCA as follows:

a. Replace the Interface PCA into position, snapping it under the retainer clip and replacing its screw.

b. Guide the IRDA PCA back into position. Be careful to get the ambient light sensor into the notch in the end of the light conducting tube. Install the 2 screws in the IRDA PCA.

c. Replace the Manual Door shaft and rails into position. Install the 4 screws from the top side of the case into the Interface PCA and tighten.

d. Reconnect the 2 flex circuits from the Manual keypad to the Interface PCA. Do not twist them.

e. Reconnect the 3 flex circuits from the Main keypad to the Interface PCA.

f. Reconnect the large ribbon cable to the Control PCA and replace its metal bail.

g. Carefully connect the SpO_2 flex circuit to the Interface PCA.

h. Connect ECG connector to Interface PCA, being sure ECG cable is above SpO_2 flex circuit.

5. Reconnect the rest of the unit as follows:

a. Replace the plastic insulating shield over the SpO_2 and Interface PCAs. Align the hole in its wide end over the case post. Slide the left edge of its narrow end under the lips on the metal retaining clips on the ECG and SpO_2 connectors. Secure the shield to the clips with the original tape, or use other plastic electrical tape.

b. Replace and reconnect the Control Stack. See "Control Stack" on page 4-33.

c. Restore any other connections, including replacing the defibrillator capacitor and plugging the battery connector back onto the Power PCA if needed.

6. Check the membrane switches as follows:

   a. Close the case but do not install screws at this time.

   b. Replace the battery, and enter Diagnostic Mode (see "Diagnostic Tests" on page 2-16).

   c. Perform the Controls Test and check each of the Manual/Pacing keys (see "To check the Controls (keys):" on page 2-19). If there are any failures, carefully reseat each of the Manual Key flexes into their connectors on the Interface PCA and try again.

   d. When the keys are known to be working, turn the power off and proceed with the installation.

7. Install the rubber overlay as follows:

   a. Clean the surfaces of the case and membrane switches (NOT the overlay) thoroughly with isopropyl alcohol (an alcohol wipe is fine). Allow to dry completely.

   b. Peel the backing material off the rubber overlay. Handle very carefully and touch the adhesive as little as possible.

   c. Starting with the top edge, align the overlay very carefully and roll it down slowly into place.

   d. Press firmly all over, especially the edges, to adhere the new overlay into place.

8. Be sure to specifically check the operation of each of the keys during Performance Verification by performing a Controls Test (see "To check the Controls (keys):" on page 2-19).

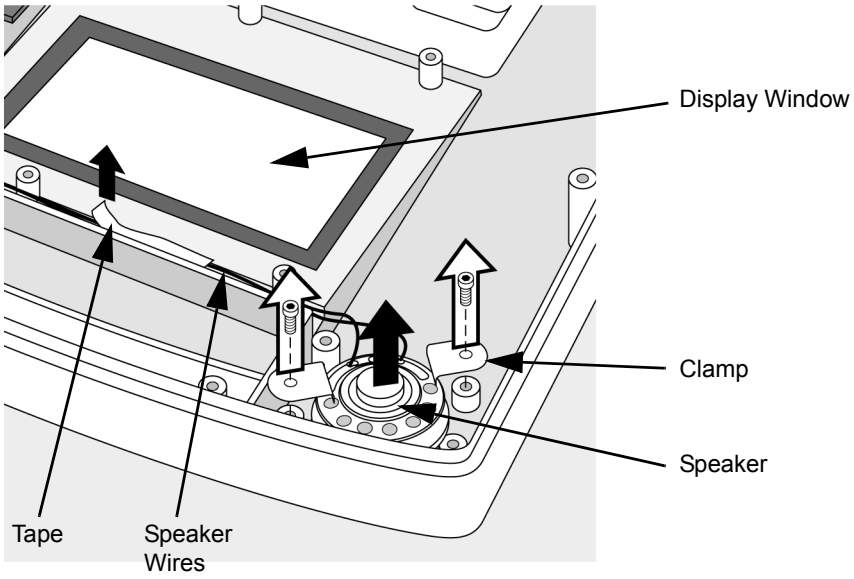
Speaker

These instructions describe how to remove and replace the speaker assembly.

Removal

1. Disconnect the speaker from the Control PCA. Refer to Figure 4-18 to identify the speaker connector.
2. Remove the 2 screws and clamps from the speaker. See Figure 4-30.
3. Peel up the tape holding the speaker wires in position. Lift the speaker and its wires out of the case.

Figure 4-30 Removing the Speaker



Replacement

1. Place the new speaker into position in the case.
2. Install both clamps and both screws.
3. Lay the wires in the same position in the case as were the original wires, and secure with the original tape (or with other plastic electrical tape).
4. Connect the speaker to the Control PCA.

Top Case Assembly

Description

The top case assembly consists of the following components, all pre assembled into the case at the factory.

- Display window.
- IRDA and Ambient Light lenses.
- Main Keypad subassembly.
- Printer ribbon cable

Should the case itself or any one of these components sustain damage, the top case assembly must be replaced.

Removal and replacement

The Top Case is probably the most difficult and time consuming repair that can be done on the M3500B/M5500B. Some parts need to be moved from the old case to the new; and new parts must be installed. Some of the new parts come with the top case and some must be ordered separately.

Parts to be moved from old top case to new

The following subassemblies must be removed from the old top case and installed into the new one. Follow the Removal and Replacement instructions in this chapter for each subassembly. Remove them in the order shown, and replace them in reverse order.

1. Printer (see "Printer Assembly" on page 4-11).
2. Manual door and label (see "Manual Door" on page 4-4).
3. Shaft and mounting rails for Manual Door ("Manual Keypad Assembly" on page 4-44).
4. Control stack ("Control Stack" on page 4-33).
5. Interface PCA, with its ribbon cable and insulating shield (see "Interface PCA" on page 4-50).
6. SpO_2 connector and flex circuit (if present) (see "SpO_2 Connector" on page 4-42).
7. ECG connector and cable with ferrite (see "ECG Connector" on page 4-40).
8. SpO_2 PCA (if present) and flex with ferrite (see "SpO2 PCA" on page 4-38). The flex circuit and ferrite will be reused.
9. Speaker, hardware, tape (see "Speaker" on page 4-55).
10. All screws.

New parts to be installed - provided with top case

The Replacement Top Case Assembly comes with the following new components, which must be installed in the field. ***Do not reuse the old parts.***:

- ECG/SpO_2 connector gaskets (not available separately)
- ECG/SpO_2 connector retaining clips (M2475-07101)

New parts to be installed - must be ordered separately

In addition, the following parts cannot be reused from the old case, and must be ordered separately and installed into the new top case:

- Branding Label Set (includes the Ambient Light sensor cover)
    a. Philips label set (M3500-69556)
    b. Laerdal North America label set (M3500-69557)
    c. Laerdal Other label set (M3500-69558)
- Manual Keypad

  These are available in 2 versions (pacing, no pacing) and in all the supported languages. See the "Replacement Parts" chapter, Table 5-7 and Table 5-8 to select the correct version and language.
- Case Label Set

  These are available in all the supported languages. See the "Replacement Parts" chapter, Table 5-12 to select the correct language.

Bottom Case Assemblies

The sections that follow describe removing and replacing assemblies that reside in the Bottom Case.

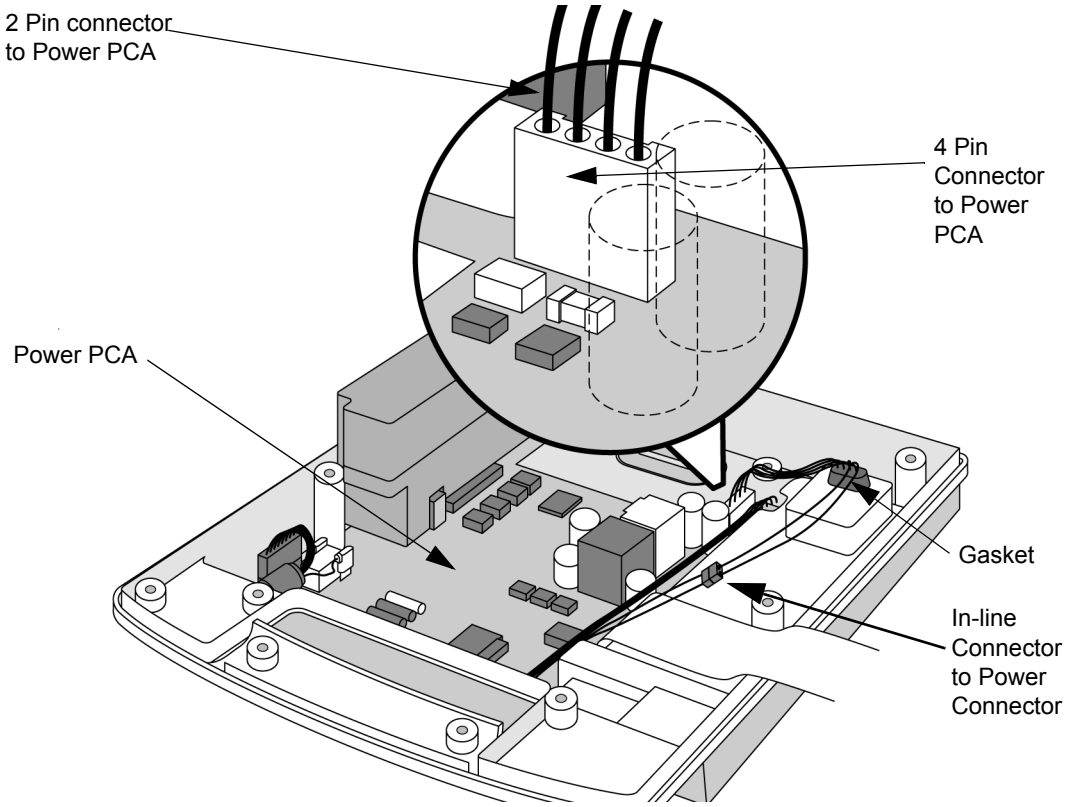
Battery PCA

The Battery PCA is mounted in the Battery compartment, under the Battery Cover. It has a cable assembly that enters the case through a rubber gasket. Once inside the case, the cable assembly connects to the Power PCA and to the Power Connector.

Removal

1. Unplug 3 connectors from the Battery PCA as shown in Figure 4-31.
   - 4 pin connector to Power PCA (battery connector).
   - 2 pin connector to Power PCA.
   - 1 in line with wires to Power Connector.
2. Pull the Battery PCA up out of its slot in the bottom case.
3. Pull out the gasket from its hole in the case. This is made easier if the tabs on the gasket are cut away with a utility knife. Be careful not to gouge the case.
4. Pull the wires out of the hole in the case.

Figure 4-31 Battery PCA connections



Replacement

1. Slide the wires on the new PCA into the hole in the case.
2. Install the new gasket into the hole. The gasket is fully seated when it protrudes out evenly around the hole on both the inside and the outside of the case.
3. Install the Battery Plate Spring onto the standoff on the Battery PCA. Install the Battery PCA into its slot in the case.
4. Flip the case over and plug in the 3 connectors (2 on Power PCA, 1 in line to Power Connector).

Defibrillator Capacitor

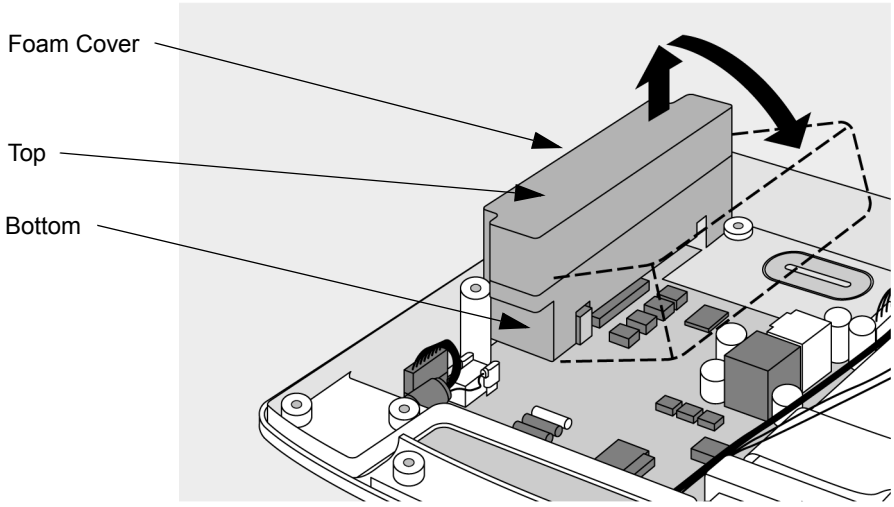
WARNING

Always discharge the defibrillator capacitor before performing any service operations on this unit.
See "Separating the Case" on page 1-25.

Removal

1. Lift the capacitor and its foam covers straight up off the Power PCA. Roll them over onto the Power PCA as shown in Figure 4-32.
2. Before disconnecting the capacitor, note the polarity and routing of its 2 wires - the red wire goes to the spade connector next to the red inductor, and the white wire goes to the spade up in the corner of the Power PCA.
3. Unplug the defibrillator capacitor from the Power PCA by pulling straight up on its spade connectors with needle nose pliers. Take care to not stress the wires.
4. Slide the wires out through the bottom piece of foam.
5. Using a clip lead, short the capacitor's terminals together to prevent charge accumulation and lay the defibrillator capacitor aside.

Figure 4-32 Removing capacitor cover



Replacement

1. The new capacitor will come with a shorting bar connecting the two terminals. Disconnect the shorting bar.
2. Slide the wires through the bottom piece of foam, routing them like the original wires.
3. Plug the terminals onto the spade connectors on the Power PCA. Note the correct polarity is with the red wire near the red inductor and the white wire near the back corner of the Power PCA.
4. Assemble the top and bottom foam pieces around the capacitor and slide the assembly down in place on the Power PCA.

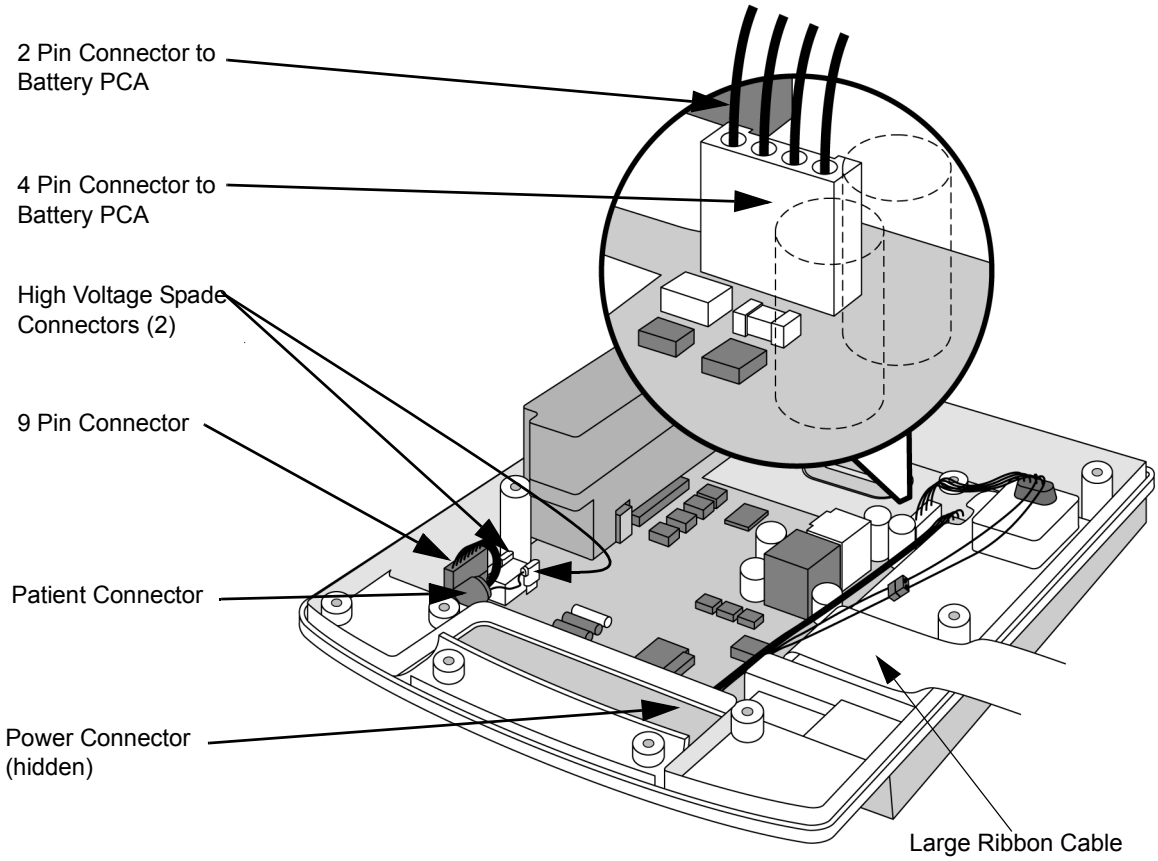
Power PCA

The Power PCA is located in the bottom case.

Removal

1. Disconnect and remove the defibrillator capacitor. See "Defibrillator Capacitor" on page 4-60.
2. Disconnect the 3 connectors from the Patient Connector to the Power PCA at the Power PCA - 2 are High Voltage spade connectors (note the correct locations before removing) and 1 is a 9 pin connector with a latch. See Figure 4-33.
3. Disconnect the 2 connectors from the Battery PCA to the Power PCA at the Power PCA - 1 large 4-pin connector that carries the battery leads (2 red + 2 black wires), and 1 small 2-pin connector with a latch.
4. Disconnect 1 4-pin connector from the Power Connector to the Power PCA at the Power PCA.
5. Disconnect the large ribbon cable from the Power PCA to the Control PCA at the Power PCA end. Unlatch and remove the metal bail (do not bend it).
6. Remove 6 T10 size screws from the Power PCA.
7. Pull the Power PCA up and guide it around the Patient Connector.

Figure 4-33 Disconnecting the Power PCA


2 Pin Connector to Battery PCA
4 Pin Connector to Battery PCA
High Voltage Spade Connectors (2)
9 Pin Connector
Patient Connector
Power Connector (hidden)
Large Ribbon Cable

Replacement

1. Place the new Power PCA into position in the case. Replace the 6 T10 screws and tighten.
1. Replace and reconnect the defibrillator capacitor. See "Defibrillator Capacitor" on page 4-60.
2. Reconnect the 3 connectors from the Patient Connector (2 individual High Voltage, 1 multipin).
3. Reconnect the 2 connectors from the Battery PCA.
4. Reconnect the 1 connector from the Power Connector.
5. Reconnect the large ribbon cable to the Control PCA. Replace and relatch the metal bail.

Power Connector

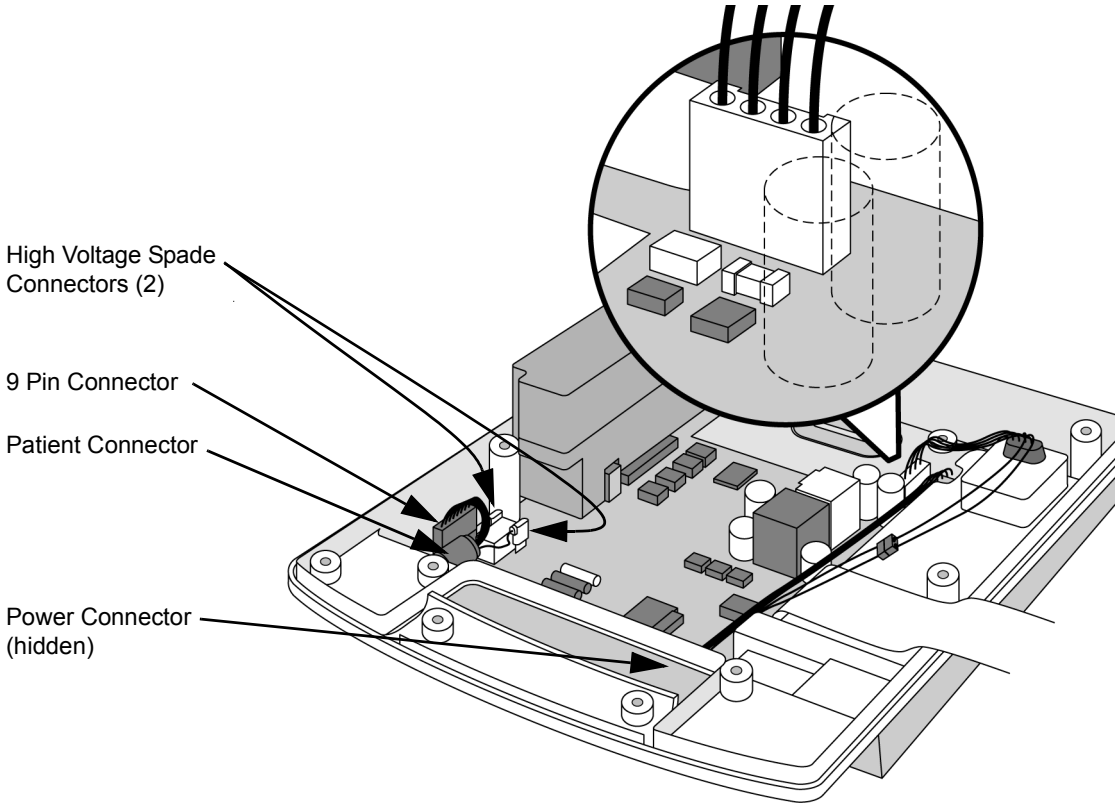
Removal

1. Disconnect 1 connector from the Power PCA (4 conductor with latch). See Figure 4-33.
2. Disconnect 1 connector in line to the battery PCA (2 conductor with latch).
3. Unscrew the large nut on the back of the connector.
4. Pull the connector and its wires and O-ring out of the case.

Replacement

1. Slide the wires of the new connector through the new O-ring that came with the connector, then insert them through the hole in the case, and then through the large nut. Use the existing nut.
2. Seat the O-ring carefully on the connector.
3. Align the flat section on the connector with the flat portion of the case hole.
4. Push the connector into the hole, seating the O-ring into the case.
5. Tighten the large nut snugly but not excessively - the goal is to compress the O-ring, not crush it hard against the case.

Figure 4-34 Power Connector and Patient Connector



Patient Connector

Removal

1. Disconnect the 3 connectors from the Patient Connector to the Power PCA at the Power PCA - 2 are High Voltage spade connectors (note the correct locations before removing) and 1 is a 9 pin connector with a latch. See Figure 4-33.
2. Unscrew the large nut on the back of the connector.
3. Pull the connector and its wires and O-ring out of the case. Guide the 9 pin connector out through the nut and through the hole in the case by turning the connector sideways.

Replacement

1. Slide the wires of the new connector through the new O-ring that came with the connector, then insert them through the hole in the case, and then through the large nut. Use the existing nut.
2. Seat the O-ring on the connector.
3. Align the flat section on the connector with the flat portion of the case hole.
4. Push the connector into the hole, seating the O-ring into the case.
5. Tighten large nut snugly but not excessively - the goal is to compress the O-ring, not crush it hard against the case.
6. Replace the 3 connectors from the Patient Connector to the Power PCA.

Bottom Case Assembly

The bottom case assembly consists of the plastic case, with the Data Card Door, Battery Cover, and Battery Eject Latch mechanism all pre installed at the factory. The bottom case must be replaced only when there is damage to the case itself; everything else in the bottom case is individually replaceable.

Parts to be moved from old bottom case to new

The following subassemblies must be removed from the old top case and installed into the new one. Follow the Removal and Replacement instructions in this chapter for each subassembly. Remove them in the order shown, and replace them in reverse order.

1. Battery PCA, spring, cable (see"Battery PCA" on page 4-58).
2. Battery eject spring (see "Battery PCA" on page 4-58).
3. Patient Connector, cables, hardware (see "Patient Connector" on page 4-65).
4. Power Connector, cables, hardware (see "Power Connector" on page 4-64).
5. Defibrillator capacitor (see "Defibrillator Capacitor" on page 4-60).
6. Power PCA and shield (see "Power PCA" on page 4-62).
7. Battery.
8. All screws.

New parts to be installed - must be ordered separately

In addition, the following parts cannot be reused from the old case, and must be ordered separately and installed into the new bottom case:

- Case Label Set

  These are available in all the supported languages. See the "Replacement Parts" chapter, Table 5-12 to select the correct language.

- Primary Label

  When replacing the bottom case, the Primary Label containing the unit's serial number must also be replaced. Be prepared to provide information identifying the unit when ordering the bottom case.

NOTE

To enable device tracking as mandated by US Federal law, the Primary Label must be applied before placing the unit back into service.

The Language Support Tool

The Language Support Tool allows field service personnel to perform several tasks: 1) to set the language of the Control PCA of the defibrillator; 2) to set the default display contrast, 3) to enable the SpO_2 option, and 4) to program in the serial number. These tasks need to be performed under the following circumstances:

- The Control PCA has been replaced.

  The Control PCA contains all the operating software, configured for the installed hardware. It also contains the unit's serial number, which was programmed in during manufacturing.

  The new Control PCA must be programmed to recognize the hardware installed in this unit, to contain that unit's serial number, and to set the lanugage of the unit.

- The unit has received an upgrade adding the SpO_2 capability.

  The added hardware will ***not*** be automatically recognized. The Control PCA must be programmed to recognize the new hardware installed.

- The unit's software is being updated.

  Software upgrades are periodically released to resolve customer issues. The Language Support tool enables you to load new software onto the unit.

Using the Support Tool

1. Have unit power off, and have either a fresh battery installed or a Power Module connected.
2. Insert the Support Tool data card into the unit.
3. Turn unit power on.
4. Follow the screen prompts.

   a. Press *Yes* to continue.
   The message "Upgrade software found Proceed to Program?" is displayed.

   b. Press *Yes* to set the unit's language. Do ***not*** press any keys or touch the unit until the process is complete.

   c. Set the default display contrast level. This value is only used when the configuration is lost. During the normal use, the unit powers up with the contrast level it was last set to.

   d. Select whether SpO_2 hardware is installed or not as appropriate.

   e. Program in the unit's serial number

- If this is an SpO_2 upgrade, the serial number should already be present. In this case, verify it against the factory-applied label on the bottom of the case.
- If this is a Control PCA replacement, program in the serial number found on the factory-applied label on the bottom of the case using the softkeys as instructed on the screen. Be sure to program it in accurately, as the serial number is used for all repair history tracking.

5. Check all the displayed information carefully before proceeding.
   - If the displayed information is correct, follow the screen prompts to save the configuration.
   - If any of the information is incorrect, follow the prompts to NOT save the configuration, then start over by powering the unit off, then back on.
6. Turn off the power. Wait 2 seconds.
7. Remove the Data Card by pressing the black eject button and pulling the Data Card from the compartment.
8. Turn the unit back on and enter Configuration Mode (see "Test and Inspection Matrix" on page 2-3).
9. Print the configuration and check it against the printout from before the servicing began. Reset the configuration (or load it from a Data Card) as needed.
10. Perform Performance Verification Testing as described in "Performance Verification and Safety Tests" starting on page 2-1.

Closing the case

The following instructions describe how to close the case.

1. Recheck all connections to all PCAs. Be sure all connectors are fully seated and latched, and all metal bails are properly installed.
2. Make sure the Data Card ejector button is pressed fully in.
3. Orient the unit flat on a smooth surface so the handle is closest to you, with the bottom case on the left next to the top case. See "Case Opened" on page 4-26.
4. Flip top case over to the left into a rightside-up position over the bottom case. Lower top case straight down, with front edge first to give extra room for the ejector button. Mate top to bottom.
5. Carefully check around all mating edges of the case for any gasket, wires, etc., sticking out between the case halves.
6. Turn the case upside down (holding the halves together with your hands) and shake it to double check for loose hardware inside.
7. Place the unit on the work surface upside down.
8. Replace the 1 T15 case screw located in the battery compartment.
9. Replace the Battery Cover as described in "Battery Cover" on page 4-15.
10. Turn the unit over rightside up. Install a battery. If the battery does not readily latch into place, check for a case screw or other hardware lodged against the battery PCA. Also check that the Battery PCA is installed correctly.
11. Turn on power and run an Extended Self Test before installing the rest of case screws (see "Extended Self Test" on page 2-17).
12. Remove the battery.
13. Turn the case over and replace the remaining 11 Torx T15 screws in their holes and tighten snugly.
14. Perform Performance Verification Testing as described in "Performance Verification and Safety Tests" starting on page 2-1.

Disposing of the M3500B/M5500B

Prior to disposing of the M3500B/M5500B, remove the battery. Then dispose of the device in accordance with local standards.

WARNING — *Disposal of the device with the battery inserted presents a potential shock hazard.*

Disposing of the SLA Battery

The M3516A/M5516A battery utilizes Sealed Lead Acid (SLA) technology. Dispose of the battery or recycle it according to local regulations for lead-containing products.

5 Replacement Parts

Overview

This chapter provides the part numbers for all replaceable assemblies and sub-assemblies.

Ordering Replacement Parts

To order replacement parts:

- In the US, call **800-447-7278.**
- Outside the US, contact your local Philips Medical Systems office.

Ordering Supplies and Accessories

To order accessories and supplies:

- In the US, visit our Medical Systems website at: www.medical.philips.com/cms and follow the links to Supplies.
- In the US, call **800-225-0230.**
- Outside the US, contact your local Philips Medical Systems Sales Office, or your authorized Philips Medical Systems Dealer or Distributor.

Key Components

Replacement assemblies marked with an asterisk (" * ") contain one or more Key Components. Key Components require detailed tracking, by recording the key component part number and either the key component's date code or its serial number. This data must be recorded for both the failed assembly and the replacement assembly.

Philips Medical Systems service personnel must record this information on the Customer Service Order (CSO).

The Key Components that are part of the replacement assemblies are listed in Table 5-15 on page 5-20.

Calling for Service - Philips HeartStart XLT

For assistance call the Response Center nearest to you, or visit our website at: www.medical.philips.com/cms.

United States of America

Medical Response Center	Tel: (800) 548-8833

Latin America

Medical Response Center	Tel: 954-835-2600

Canada

Medical Response Center	Tel: 800-323-2280

Other International Areas

Australia	France
Tel: 131147	Tel: 0803 35 34 33

Germany	Italy
Tel: 0180 5 47 50 00	Tel: 800-825087

Netherlands	United Kingdom
Tel: 31 20 547 2555 Fax: 31 29 547 2949	Tel: 00 44 7002 432584

Belgium (for Dutch)	Belgium (for French)
Tel: 32 2 525 7102 Fax: 32 2 525 71 91	Tel: 32 2 525 710 3 Fax: 32 2 525 71 91

Spain	Poland
Tel: 34 902 30 40 50 Fax: 34 91 326 39 66	Tel: 48 22 5710499

Austria	Finland
Tel: 43 1 60101 820	Tel: 09 6158 0400

Switzerland	Russia
Tel: 0800 80 10 23	Tel: 7 095 933 0339 Fax: 7 095 933 0338

Calling for Service - Laerdal Heartstart 4000

For telephone assistance, call the Laerdal office nearest to you.

United States of America

Laerdal Medical Corporation	Tel: (800) 547-4781

International Customers

Australia	United Kingdom
Tel: 61-3-95694055	Tel: 44-1689-876634

Norway	Other International Areas
Tel: 946-71-700	Tel: 47-51511700

Norway	
Tel: 946-71-700	

Special Tools

The following special tools are available for purchase from i Technologies at the replacement parts numbers given above.

Tool	Part Number
• Torx driver kit	5181-1933
• High voltage discharge tool	M2475-69572
• Language Support Tool	See Table 5-2 on page 5-7

M3500B Unit Exchange Program

For customers taking advantage of the M3500B Unit Exchange program, the following are notes on logistics and a list of the available Exchange Units.

Logistics

- Philips ships a replacement unit to the customer. This unit does NOT include cables, sensors, accessories, battery, data card, carry case, or consumables.
- Customer takes the exchange unit out of the box, tests it, and puts it into service.
- Customer removes all cables, sensors, accessories, battery, data card, carry case, and consumables from defective unit.
- Customer cleans and decontaminates the defective unit.
- Customer packs the defective unit into the box and ships it to Philips. Return shipping instructions are included with the exchange unit.

Table 5-1 M3500B Unit Exchange Part Numbers

Description	Part Number
M3500B Base Unit - American English	M3500-68900
M3500B Base Unit - French	M3500-68901
M3500B Base Unit w/Pacing - American English	M3500-68910
M3500B Base Unit w/Pacing - French	M3500-68911
M3500B Base Unit w/SpO_2 - American English	M3500-68920
M3500B Base Unit w/SpO_2 - French	M3500-68921
M3500B Base Unit w/SpO_2 and Pacing - American English	M3500-68930
M3500B Base Unit w/SpO_2 and Pacing - French	M3500-68931

Replacement Parts Tables

These tables provide part numbers for ordering specific replacement assemblies and parts.

Electrical Assemblies

Table 5-2	"Language Support Tool"
Table 5-3	"Other Replacement PCAs"
Table 5-4	"Other Electrical Assemblies"
Table 5-5	"Individual Electrical Parts"

Mechanical Assemblies

Table 5-6	"Replacement Manual Door Assembly"
Table 5-7	"Replacement Manual Keypad Assembly - Without Pacing"
Table 5-8	"Replacement Manual Keypad Assembly - With Pacing"
Table 5-9	"Other Mechanical Assemblies"
Table 5-10	"Connectors"
Table 5-11	"Individual Mechanical Parts"
Table 5-12	"Case Label Sets"
Table 5-13	"Other Labels"

Supplies and Accessories

Table 5-14	"Supplies and Accessories"

Key Components

Table 5-15	"Key Components"

Electrical Assemblies

The following tables provide information about replacement electrical assemblies.

Control PCA

The replacement Control PCA includes the Lithium backup battery, the battery's cable tie wrap, and the black plastic shield for the Data Card receptacle entrance.

All Control PCAs are American English, part number M3500-68100. Use the appropriate Language Support tool to set the Control PCA to the correct language.

NOTE

The Control PCA is a key component which requires tracking. See Table 5-15 on page 5-20.

Table 5-2 Language Support Tool

Language	Part Number
American English	M3500-87900
French	M3500-87901
German	M3500-87902
Dutch	M3500-87903
Spanish	M3500-87904
Italian	M3500-87905
Swedish	M3500-87906
Japanese	M3500-87907
Norwegian	M3500-87908
Finnish	M3500-87909
Portuguese	M3500-87913
Russian	M3500-87914
Korean	M3500-87915
Polish	M3500-87919
British English	M3500-87930
Australian English	M3500-87940
8 MB card for SoftServer use	M3500-87890

Other Replacement PCAs

These PCAs come with specific parts as noted.

Table 5-3 Other Replacement PCAs

Description	Part Number	Notes
Power PCA with pacing	M3500-68110 *	
Power PCA without pacing	M3500-68111 *	
Interface PCA	M3500-68120 *	Includes IRDA break-off PCA. ***Must also order Manual Keypad Assembly (Table 5-7 and Table 5-8).***
Battery PCA	M3500-66130 *	Includes spring, cable, main fuse.
SpO_2 PCA	M3500-68126	Includes flex circuit, ferrite, adhesive patch

Items marked with an asterisk (" * ") contain Key Components which require tracking. See Table 5-15 on page 5-20.

Other Electrical Assemblies

These assemblies come with specific parts as noted.

Table 5-4 Other Electrical Assemblies

Description	Part Number	Notes
Printer assembly	M1722-69520	
LCD display	M3500-69551 *	Includes thermistor, display data flex circuit
Defibrillator Capacitor Assembly	M3500-69564 *	
Speaker Assembly	M3500-69552	Includes speaker, cable.

Items marked with an asterisk (" * ") contain Key Components which require tracking. See Table 5-15 on page 5-20.

Individual Electrical Parts

These electrical parts are available separately.

Table 5-5 Individual Electrical Parts

Description	Part Number	Notes
Lithium Backup Battery	M3500-69565	Includes battery, ProGold wipes, and cable tie wrap
Main Fuse (25A, 32V)	2110-0250	Pkg. of 5

Mechanical Assemblies

The following tables provide information about replacement mechanical assemblies.

Manual Door

Includes 5 each of the door, and 5 each of the door label sets. Each label set contains 2 door labels (top and bottom of door) in 2 versions (for units both with and without pacing).

Table 5-6 Replacement Manual Door Assembly

Language	Part Number
English	M3500-69600
French	M3500-69601
German	M3500-69602
Dutch	M3500-69603
Spanish	M3500-69604
Italian	M3500-69605
Swedish	M3500-69606
Japanese	M3500-69607
Norwegian	M3500-69608
Finnish	M3500-69609
Portuguese	M3500-69613
Russian	M3500-69614
Polish	M3500-69619

Manual Keypad Assembly

Each assembly below contains both the membrane switches and the rubber overlay.

Table 5-7 Replacement Manual Keypad Assembly - Without Pacing

Language	Part Number
English	M3500-69510 *
French	M3500-69511 *
German	M3500-69512 *
Dutch	M3500-69513 *
Spanish	M3500-69514 *
Italian	M3500-69515 *
Swedish	M3500-69516 *
Japanese	M3500-69517 *
Norwegian	M3500-69518 *
Finnish	M3500-69519 *
Russian	M3500-69520 *
Polish	M3500-69521 *
Portuguese	M3500-69522 *

Items marked with an asterisk (" * ") contain Key Components which require tracking. See Table 5-15 on page 5-20.

Table 5-8 Replacement Manual Keypad Assembly - With Pacing

Language	Part Number
English	M3500-69530 *
French	M3500-69531 *
German	M3500-69532 *
Dutch	M3500-69533 *
Spanish	M3500-69534 *
Italian	M3500-69535 *
Swedish	M3500-69536 *
Japanese	M3500-69537 *
Norwegian	M3500-69538 *
Finnish	M3500-69539 *
Russian	M3500-69540 *
Polish	M3500-69541 *
Portuguese	M3500-69542 *

Items marked with an asterisk (" * ") contain Key Components which require tracking. See Table 5-15 on page 5-20.

Other Mechanical Assemblies

These assemblies come with specific parts as noted.

Table 5-9 Other Mechanical Assemblies

Description	Part Number	Notes
Data Card Door Assembly	M3500-69560	Includes door, latch, pivot/spring assembly.
Battery Eject Assembly	M3500-69561	Includes catch, button, spring.
Top Case Assembly	M3500-69550 *	Includes Main Keypad Assembly; LCD Display window; IRDA window and light tube; speaker label; retainer clip, plug and gasket for SpO_2 hole; additional retainer clip and gasket for ECG connector; printer ribbon cable. ***Must also order Branding Label Set (Table 5-13), Manual Keypad (Table 5-7 and Table 5-8), and Case Label Set (Table 5-12).***
Bottom Case Assembly	M3500-69549	Includes Battery Cover, Battery Eject Mechanism, Data Card Door, gaskets. ***Must also order Case Label Set (Table 5-12).***
Note: When ordering the Bottom Case, be sure to order the Primary Label as well. When ordering, be prepared to provide information from the existing label (model number, serial number, options), plus customer information (name and address), and information identifying the service person (name, address).		

Items marked with an asterisk (" * ") contain Key Components which require tracking. See Table 5-15 on page 5-20.

Connectors

These replacement connectors come with specific parts as noted.

Table 5-10 Connectors

Description	Part Number	Notes
ECG Connector Assembly	M3500-69553	Includes connector, gasket, retainer clip, cable and ferrite, cable tie.
SpO_2 Connector Assembly	M3500-69554	Includes connector, gasket, flex cable, retainer clip
Patient Connector Assembly	M3500-69562 *	Includes connector, O-ring, internal cables
Power Connector Assembly	M3500-69563 *	Includes connector, O-ring, internal cables

Items marked with an asterisk (" * ") contain Key Components which require tracking. See Table 5-15 on page 5-20.

Individual Mechanical Parts

These mechanical parts are available separately.

Table 5-11 Individual Mechanical Parts

Description	Part Number	Notes
Cable Tie Wrap	1400-0577	Same tie wrap used with ECG Connector assembly and on Lithium Battery (included in Lithium Backup Battery kit).
ECG/SpO_2 Connector Retainer Clip	M2475-07101	Used on both ECG and SpO_2 connectors.
T10 (M3X6) screws	0515-0430	Used for battery cover, interior assemblies, PCAs
T15 (M4X10) screws	0515-0380	Used for case exterior

Labels

The following tables give information about the various labels used on the M3500B/M5500B.

Case Label Sets

The case label set includes most of the labels on the top and bottom case, except those that vary with the brand under which the product is sold (Philips or Laerdal). This set includes:

- AED Operation label
- Printer key label
- OFF / ON label
- DANGER / WARNING / IPX4 label
- Printer latch label (arrow)
- Power Connector label
- Pads Connector label
- EJECT Data Card label
- Blank yellow label
- ECG/SpO_2 labels

The Case Label Set is available in the following supported languages.

See Figure 4-11 on page 4-20 for correct placement of these labels.

Table 5-12 Case Label Sets

Language	Part Number
English	M3500-69700
French	M3500-69701
German	M3500-69702
Dutch	M3500-69703
Spanish	M3500-69704
Italian	M3500-69705
Swedish	M3500-69706
Japanese	M3500-69707
Norwegian	M3500-69708
Finnish	M3500-69709
Portuguese	M3500-69713
Russian	M3500-69714
Polish	M3500-69719

Other Labels

These labels are also available.

Table 5-13 Other Labels

Description	Part Number	Notes
Speaker Label Set (cover)	M3500-69555	For proper placement see Figure 4-12 (page 4-21).
Philips Label Set - Branding Labels Worldwide	M3500-69556	Includes Philips branding label, ambient light sensor label. For proper placement see Figure 4-12 (page 4-21).
Laerdal USA Label Set - Branding Labels for North America (US and Canada)	M3500-69557	For Laerdal use in North America only. Includes Laerdal branding label, HeartStart label, ambient light sensor label. For proper placement see Figure 4-12 (page 4-21).
Laerdal Other Label Set - Branding Labels for outside of North America	M3500-69558	For Laerdal use outside of North America only. Includes Laerdal branding label, HeartStart label, ambient light sensor label. For proper placement see Figure 4-12 (page 4-21).
Printer Label Set	M3500-69559	Includes arrow label for printer latch. For proper placement see Figure 4-11 (page 4-20).

Supplies & Accessories

Approved supplies and accessories for the M3500B/M5500B are listed in . To order:

- In the USA, call **1-800-225-0230**.
- Outside the USA, contact your local Philips Medical Systems Sales Office, your authorized Philips Medical Systems Dealer or Distributor, or visit our website at: www.medical.philips.com/cms and follow the Supplies link.

Table 5-14 Supplies and Accessories

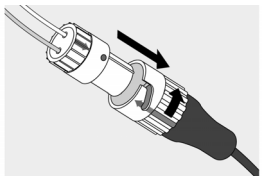
Part Number	Description
Paper	
40457C	50 mm Strip Chart Thermal Paper - 1 box (10 rolls)
40457D	50 mm Strip Chart Thermal Paper - 1 box (80 rolls)
Defibrillation Pads, Pads Cables and Test Load (white twist lock connector) 	
M3501A	Multifunction Adult defib pads, AAMI.
M3502A	Multifunction Adult defib pads, IEC.
M3503A	Multifunction Pediatric defib pads, IEC.
M3504A	Multifunction Pediatric defib pads, AAMI.
M3507A *	Defib pads cable, barrel connector.
M1781A	50 ohm defibrillator test load, barrel connector.
05-10200	HeartStart Pads Adapter, barrel connector. Connects to M3507A pads connector cable.

Table 5-14 Supplies and Accessories *(Continued)*

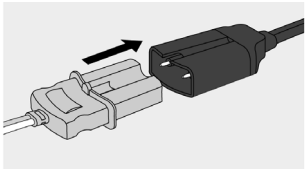
Part Number	Description
Defibrillation Pads, Pads Cables, Adapters and Test Load (gray flat connector)	
M3713A	Multifunction Adult Plus Pads - Adult Plus multifunction defib pads (general use).
M3716A	Multifunction Adult Radiolucent Pads - Adult Radiolucent multifunction defib pads (special purpose - for X-ray and special procedures).
M3717A	Multifunction Pediatric Plus Pads - Pediatric multifunction defib pads (general use).
M3718A	Multifunction Adult Radiotransparent/Reduced Skin Irritation Pads - Adult Radiotransparent/Reduced Skin Irritation multi-function defib pads (special purpose - for X-ray and special procedures).
M3719A	Multifunction Pediatric Radiotransparent/Reduced Skin Irrita-tion Pads - Pediatric Radiotransparent/Reduced Skin Irritation multifunction defib pads (special purpose - for X-ray and special procedures).
M3508A *	Defibrillator pads cable, plug connector.
M3725A	50 ohm defibrillator test load, plug connector.

Table 5-14 Supplies and Accessories *(Continued)*

Part Number	Description
ECG Cables	
M1733A	3-lead ECG Trunk cable, AAMI (8-pin).
M1734A	5-lead ECG Trunk cable, AAMI (8-pin).
M1735A	3-lead ECG Trunk cable, IEC (8-pin).
M1736A	5-lead ECG Trunk cable, IEC (8-pin).
M1580A	3-lead ECG Trunk cable, AAMI (8-pin)
M1600A	5-Lead ECG Trunk Cable, AAMI ((8-pin)
M1590A	3-lead ECG Trunk Cable, IEC (8-pin)
M1610A	5-Lead ECG Trunk Cable, IEC (8-pin)
Monitoring Electrodes	
M2202A	High-Tack Foam ECG Electrodes - 5 electrodes/pouch (300 electrodes/case)
SpO_2 Cable/Sensors	
M1191A	Adult Reusable SpO_2 sensor.
M1192A	Pediatric Reusable SpO_2 sensor.
M1194A	Adult/Pediatric Ear Clip, Reusable SpO_2 sensor
M1941A	SpO_2 extension cable (2 m).
M1943A	Nellcor SpO_2 Sensor adapter cable.
Data Card	
M3510A/ M5510A	Data Card.

Table 5-14 Supplies and Accessories *(Continued)*

Part Number	Description
Battery/Power Modules/ Adapter	
M3516A/ M5516A *	Sealed Lead Acid Battery.
M3517A / M5517A *	AC power module.
M3518A/ M5518A *	DC Power Module
M3506A/ M5506A	Battery charger adapter.
Extension Cable	
M4748A	Adapter extension cable
Carrying Case	
M3509A/ M5509A	Carrying case. (If a new Quick Reference Card is needed for the carrying case, it must be ordered separately.)

*Items marked with an asterisk (*) contain Key Components which require tracking.**See Table 5-15 on page 5-20.*

Key Components

Key components require tracking as indicated below. Record the Part Number and either the Date Code or Serial Number for both the failed component and the replacement component.

Table 5-15 Key Components

Replacement Assembly		Key Component		
Description	**Part Number**	**Description**	**Part Number**	**Tracking Method**
Electrical Assemblies				
Control PCA		Control PCA	M3500-68100	Serial Number
Power PCA				
With Pacing	M3500-68110	Power PCA	M3500-61110	Serial Number
Without Pacing	M3500-68111	Power PCA	M3500-61111	Serial Number
Other Replacement PCAs				
Interface PCA	M3500-68120	Interface PCA	M3500-61120	Serial Number
Battery PCA	M3500-66130	Battery PCA	M3500-60130	Date Code
Other Electrical Assemblies				
LCD Display	M3500-69551	LCD Display	2090-0374	Serial Number
Defibrillator Capacitor	M3500-69564	Defibrillator Capacitor	010879-0004	Serial Number ***and*** Date Code

Table 5-15 Key Components *(Continued)*

Replacement Assembly		Key Component		
Description	**Part Number**	**Description**	**Part Number**	**Tracking Method**
Mechanical Assemblies				
Manual Keypad Assembly - Without Pacing		Manual Switch Assembly (membrane switches)	M3500-60220	Date Code
English	M3500-69510			
French	M3500-69511			
German	M3500-69512			
Dutch	M3500-69513			
Spanish	M3500-69514			
Italian	M3500-69515			
Swedish	M3500-69516			
Japanese	M3500-69517			
Norwegian	M3500-69518			
Finnish	M3500-69519			
Russian	M3500-69520			
Polish	M3500-69521			
Portuguese	M3500-69522			
Manual Keypad Assembly - With Pacing		Manual Switch Assembly (membrane switches)	M3500-60210	Date Code
English	M3500-69530			
French	M3500-69531			
German	M3500-69532			
Dutch	M3500-69533			
Spanish	M3500-69534			
Italian	M3500-69535			
Swedish	M3500-69536			
Japanese	M3500-69537			
Norwegian	M3500-69538			
Finnish	M3500-69539			
Russian	M3500-69540			
Polish	M3500-69541			
Portuguese	M3500-69542			

Table 5-15 Key Components *(Continued)*

Replacement Assembly		Key Component		
Description	**Part Number**	**Description**	**Part Number**	**Tracking Method**
Other Mechanical Assemblies				
Top Case Assembly	M3500-69550	Main Keypad Assembly	M3500-67200	Date Code
Connectors				
Patient Connector Assembly	M3500-69562	Patient Connector Assembly	M3500-62601	Date Code
Power Connector Assembly	M3500-69563	Power Connector Assembly	M3500-62602	Date Code
Pads Cables				
Defib Pads Cable, barrel connector	M3507A	Defib Pads Cable, barrel connector	M3507-6007	Date Code
Defib Pads Cable, plug connector	M3508A	Defib Pads Cable, plug connector	M3508-60008	Date Code
Battery/Power Modules				
Sealed Lead Acid Battery	M3516A/M5516A	Sealed Lead Acid Battery	1420-0561	Date Code
AC Power Module	M3517A/M5517A	AC Power Module	M3517-6000	Date Code
DC Power Module	M3518A/M5518A	DC Power Module	M3518-6001	Date Code

6 Theory of Operation

Overview

This chapter describes the internal operation of the M3500B/M5500B. This description is at the functional-block level.

The information is presented in two ways:

- PCA Descriptions

  For each Printed Circuit Assembly (PCA), a description of the major functions performed on that PCA.

- System Functional Descriptions

  For each major system function, a description of how the signal is routed through the various PCAs.

In these descriptions, reference will be made to PCAs or features which are optional and may not be present in the unit you have. In that case, simply ignore those sections. The remaining PCA and Functional descriptions will still apply.

PCA Descriptions

The sections following provide descriptions of the functions handled by each PCA.

Control PCA

The Control PCA performs the following functions:

- System level processing.
- System level control and clock functions, including:
    a. Control of power up and power down sequences.
    b. Storage of configuration selections made by the user.
    c. Storage of operating software, including data for generating display formats and graphics.
- Main interconnection site between the other PCAs.
- User interface functions, including:
    a. Generation and control of tones and audio prompts.
    b. Generation and formatting of real-time information for the display and for the printer.
    c. Control of display backlight and contrast to compensate for ambient light and temperature.
    d. Control of printer functions.
    e. Control of indicator LEDs for Manual, Sync and Pacer keys.
- Control of data to and from the Data Card.
- Control of defibrillation functions on the Power PCA:
    a. Initiating a capacitor charge sequence.
    b. Monitoring charge on capacitor.
    c. Initiating a shock delivery sequence.
- Control of pacing functions on the Power PCA:
    a. Starting/stopping pacing.
    b. Controlling Rate and Output as selected by user, and monitoring pacing current delivered.
- Control of the ECG front ends on the Interface PCA (Leads ECG) and Power PCA (Pads ECG).
- Generation and regulation of the 5 volt logic power supply.

Interface PCA

The Interface PCA performs the following functions:

- Interconnection site for:
    a. ECG leads cable and SpO_2 module.
    b. All front panel keys.
    c. All front panel LEDs (Manual, Sync, Pacer).
    d. Ambient light sensor and IRDA interface.
- ECG analog front end for ECG from 3/5-lead cables.
- Detecting and initial processing of front panel key presses, except for keys **OFF, 1, 2, 3** which only pass through the Interface PCA and are detected and processed on the Control PCA.
- SpO_2 on/off logic and patient isolation.
- Interface for ambient light sensor.
- Interface for IrDA module (used only in manufacturing at this time).

Power PCA

The Power PCA performs the following functions:

- Analog front end for ECG from pads.
- Measurement of Patient Contact Impedance (PCI).
- Generation and control of pacing waveforms as directed by Control PCA.
- Control of defibrillator functions as directed by the Control PCA:
    a. Charging the capacitor to the correct energy level.
    b. Delivering the shock and controlling the waveform.
    c. Disarming (discharging) the capacitor.

SpO_2 PCA

The SpO_2 PCA serves as the interface to the SpO_2 sensor, including:

- Generation and control of voltages to drive the LEDs in the sensor.
- Receiving and processing the signals from the SpO_2 sensor.

Battery PCA

The Battery PCA provides the contacts with which the battery mates. It also has the main fuse, and it provides the function of detecting whether the installed battery is an M3516A/M5516A battery or not (see "Contacts/Battery Type" on page 6-16). It also detects the temperature of the battery.

Battery

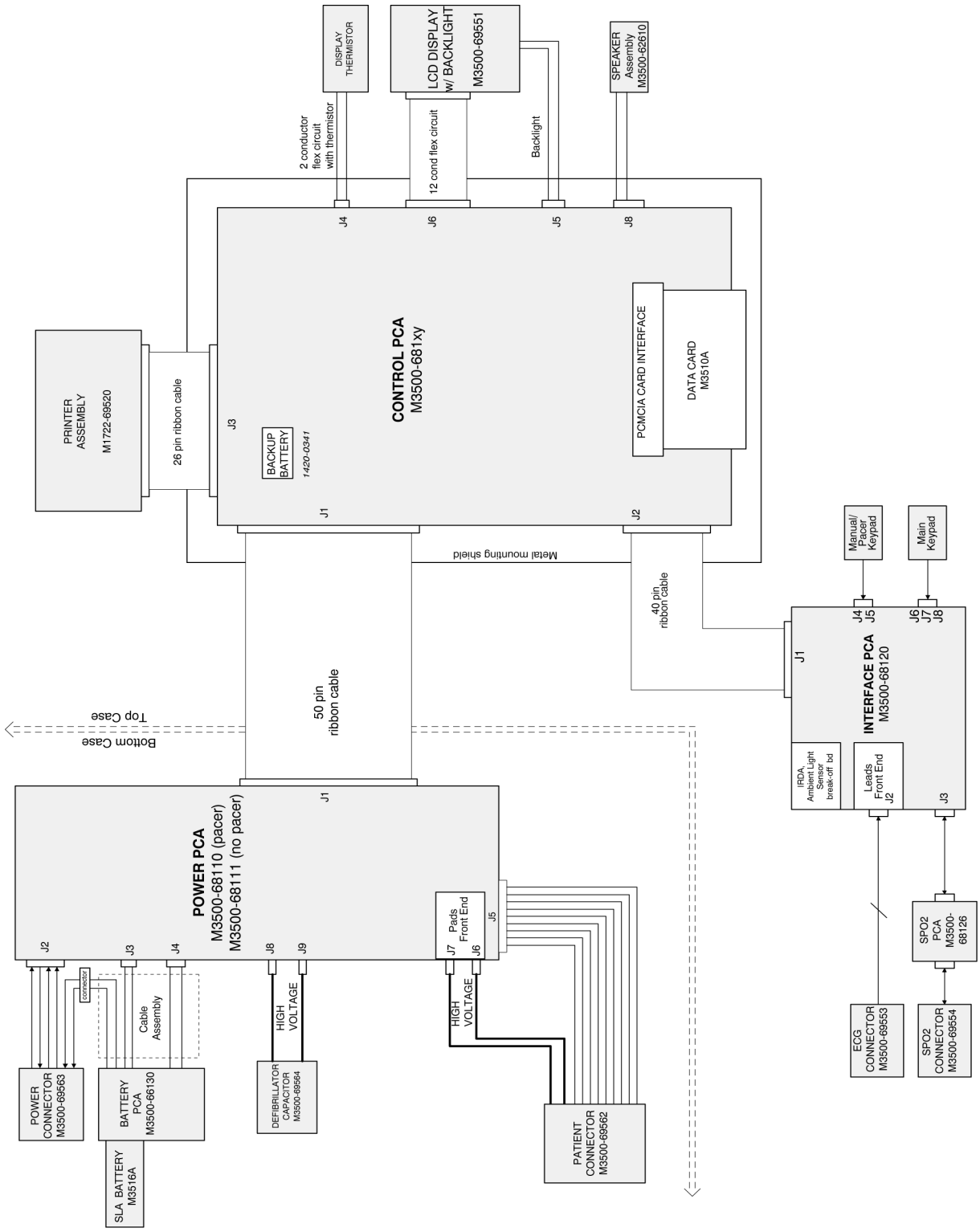
The M3516A/M55176A battery differs from similar batteries in that it is capable of providing much higher current without causing an internal protection device to open and disconnect the battery.

Printer

The printer provides hard copy output of text, waveforms, event data, etc. It senses when the paper is out, or the door is left open.

System Level Interconnections

Figure 6-1 System Interconnections



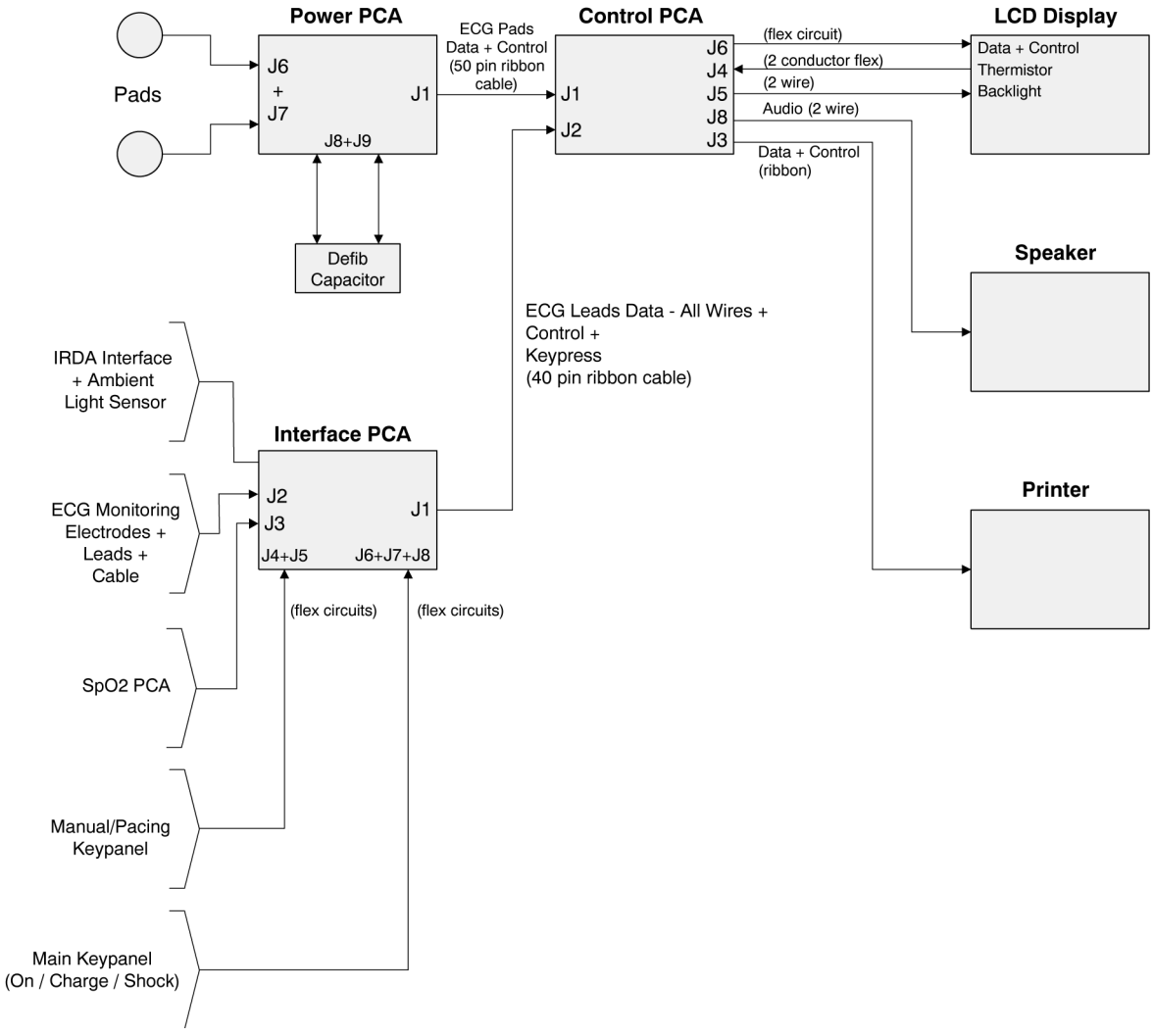
System Functional Descriptions

For all of the descriptions below, refer to Figure 6-2 "Signal and Data Flow".

Signal and Data Flow

Below is a high level block diagram representing how signals and data flow to and from the PCAs.

Figure 6-2 Signal and Data Flow



ECG Monitoring Functions

There are two separate ECG front ends - one for signals coming in on the pads cable, and one for signals coming in on the 3- or 5-lead ECG cable.

ECG - Pads

The ECG signal picked up by the disposable defibrillation pads is carried by the pads cable to the pads connector, and then to the Power PCA. There it is amplified, filtered, digitized and passed across a patient isolation barrier before being passed to the Control PCA via a large ribbon cable.

The Control PCA then performs digital signal processing on the ECG data, and is responsible for

- ECG waveform analysis and Shock Advisory (in AED Mode).
- Formatting and presenting the ECG to the display and to the printer.
- Counting heart rate and generating heart rate alarms.
- Reporting on the status of the patient connection.

ECG - 3/5-lead cable

The ECG signal picked up by the ECG monitoring electrodes is carried by the ECG cable to the ECG connector, and then to the Interface PCA. There it is amplified, filtered, and digitized before being passed to the Control PCA via a large ribbon cable.

The Control PCA then performs digital signal processing on the ECG data, and is responsible for

- Formatting and presenting the ECG to the display and to the printer.
- Counting heart rate and generating heart rate alarms.
- Reporting on the status of the patient connection, and alerting the user to measurement problems.

Patient impedance functions

The M3500B/M5500B measures patient impedance in 2 ways: an impedance measurement before the shock, and a resistance measurement during the shock.

Before the Shock

The M3500B/M5500B makes a small-signal AC impedance measurement (at 32 kHz) in the steady state situation before a shock is delivered. This measurement (called PCI) is used to determine whether the pads are connected to the patient, or not. The unit only displays this value in Diagnostic Mode, as part of the ECG test.

During the Shock

The M3500B/M5500B also makes a resistance measurement during shock delivery. This resistance is derived from measurements of voltage and current, and is reported on the printed event summary. The unit uses this value to determine whether to abort the shock, or to allow it to complete.

Since one is a small signal AC measurement of impedance and the other is a high voltage/high current measurement of resistance, it is normal and expected for them to produce slightly different numerical results.

SpO_2 Monitoring Functions

The SpO_2 signal from the sensor is carried by the external SpO_2 cable to the SpO_2 connector, and then to the SpO_2 PCA via a flex circuit. There it is amplified, filtered, and digitized before being passed to the Interface PCA via another flex circuit. (Power for the SpO_2 PCA and sensor is provided by the Interface PCA via this same flex circuit.) The Interface PCA provides on/off logic, patient isolation, and the power supply for SpO_2. It then sends the data to the Control PCA via a large ribbon cable.

The Control PCA is then responsible for:

- Formatting and presenting the O_2 saturation level, pulse rate and pleth bar to the display.
- Counting pulse rate, generating O_2 saturation level alarms.
- Reporting on the status of the sensor and its connections, and alerting the user to measurement problems.

Defibrillation Functions

The following sections describe the defibrillation functions.

Charging

There are 2 events that can initiate a charging cycle:

- In AED Mode, when the analysis algorithm determines a shock is needed and sends a signal to another section of the Control PCA.
- In Manual Mode, when front panel key #2 (*CHARGE*) is pressed, the keypress is transferred from the key to the Interface PCA via a flex circuit. The Interface PCA transfers the keypress to the Control PCA via a large ribbon cable. The keypress is then detected and processed by the Control PCA.

In either case, the charging cycle is initiated and controlled by the Control PCA. It directs the Power PCA to begin charging the charge capacitor, and it monitors the voltage on the capacitor as reported back by the Power PCA.

When the Control PCA detects that the selected energy (voltage) level has been reached, it directs the Power PCA to stop charging. The Control PCA then continues to monitor the voltage on the capacitor, and as the voltage bleeds down it directs the Power PCA to top up the charge to the correct level.

Should a decision be made to change the selected energy to a lower value, the user would scroll up through the displayed energy level choices, go past 200 J, then start scrolling up again from 5 J. At the 200 J to 5 J transition, the Control PCA directs the Power PCA to disarm (completely discharge) the capacitor. The user can then select the new energy level and charge normally.

If the requested charge is not used within 30 seconds, the Control PCA automatically directs the Power PCA to disarm the capacitor as a safety precaution.

Delivering a shock

The discharging cycle (delivering a shock) is initiated by only one event - pressing front panel key #3 (*SHOCK*). This keypress is transferred from the key to the Interface PCA via a flex circuit. The Interface PCA transfers the keypress to the Control PCA via a large ribbon cable. The keypress is then detected and processed by the Control PCA.

The Control PCA directs the Power PCA to deliver the shock. Patient resistance is derived from the current and voltage delivered during the initial portions of the waveform, and the biphasic waveform is then adjusted as needed to deliver the correct energy.

The Power PCA will abort delivery of the shock if any of the following occurs:

- During the impedance measurement, the impedance is outside of operating limits (too high or too low).

- At any time during delivery of the shock, it detects an open circuit (voltage too high for that point in the waveform) or a short circuit (current too high for that point in the waveform).

Should any of these conditions be detected, the Power PCA terminates delivery of the waveform and disarms the capacitor. The problem is reported to the Control PCA, which displays and/or prints the appropriate messages.

Another safety feature is the presence of a identification resistor in the pads cable. If the unit does not sense that resistance, it gives a *Cable Off* message and will not charge the capacitor.

Delivering synchronized cardioversion

Synchronized cardioversion operates the same as delivering a shock, except that the shock must be synchronized to the R wave of the ECG. The Control PCA is responsible for detecting the R wave and placing markers on the printed strip and on the display to indicate the timing of the proposed cardioversion shock.

To deliver a synchronized shock, key #3 (*SHOCK*) is pressed and held until the next time an R wave is detected. When both events occur (key press and R wave) the Control PCA directs the Power PCA to deliver the shock.

Pacing Functions

Pacing is initiated and controlled by pressing front panel keys. These key presses are transferred from the keys to the Interface PCA via a flex circuit. The key presses are detected and processed by the Interface PCA and then passed to the Control PCA via a large ribbon cable.

The Control PCA directs the Power PCA to deliver the pacing pulses at the rate and with the output selected by the user. The pacing pulses are delivered via the pads cable to the defibrillation pads. The pacing current delivered is reported back to the Control PCA, which sends the info to the display and activates any printouts or screen messages as needed.

Audio Functions

The M3500B/M5500B has 2 types of audio output: tones, and voice prompts. Both are generated and controlled by the Control PCA, which also amplifies the signals and passes them directly to the speaker via a dedicated connector and wire pair.

Display Functions

All display functions are handled by the Control PCA. Display formats, graphics, waveforms, numeric values, and messages are all generated and formatted by the Control PCA, using either data it has or data it receives from other parts of the unit.

Contrast - manual control

The display contrast is controlled by pressing front panel keys. These key presses are transferred from the keys to the Interface PCA via a flex circuit. The key presses are detected and processed by the Interface PCA and then passed to the Control PCA via a large ribbon cable.

Contrast - automatic control

The display contrast is also controlled automatically by the Control PCA based on ambient temperature. The temperature sensor is located on the display; it is connected to the Control PCA via a dedicated connector and wire pair.

Backlight

The backlight on the display is controlled automatically by the Control PCA based on ambient light levels. The light sensor is located on the IRDA/Light Sensor break-off PCA; its signal is routed via a soldered (non-removable) flex circuit to the Interface PCA. From there it is routed to the Control PCA via a flex cable.

The Control PCA then decides whether the backlight is needed (or not), and sends the appropriate signals to the backlight control circuits (also on the Control PCA), which turn the backlight on or off..

When the unit is powered up, the backlight turns ON initially, then turns OFF if it isn't needed.

There is a non-replaceable 0.25A fuse on the Control PCA. If there is a fault in the backlight, it may blow this fuse. Therefore, if the backlight stops working and replacing the display doesn't correct it, replace the Control PCA as well.

Indicator Functions

All panel LEDs (Manual, Sync, Pacer) are controlled by the Control PCA. The LEDs are connected into the Interface PCA via flex circuits; they are then routed to the Control PCA via a ribbon cable.

Key Functions

All front panel keys connect to the Interface PCA via flex circuits.

Main Keys

The key presses from the 4 main keys (OFF, 1, 2, 3) pass through the Interface PCA and then on to the Control PCA via a large ribbon cable. The Control PCA then interacts with the other parts of the system as needed to respond to the keypress.

Other Keys

Keypresses from all other keys (printer, display, manual/pacing) are detected and processed by the Interface PCA and then passed to the Control PCA via a large ribbon cable. The Control PCA then interacts with the other parts of the system as needed to respond to the keypress.

Printing Functions

All printing data are handled by the Control PCA. Waveforms, graphics, numeric values, and messages are all generated and formatted by the Control PCA, using either data it has or data it receives from other parts of the unit. This data is then passed to the Printer via the printer ribbon cable.

Contrast

The printing contrast is controlled automatically by the Printer itself. The printhead senses its own temperature and impedance, and passes that information to the Control PCA. The Control PCA adjusts drive voltage to the printhead (and thus contrast) based on these readings and on battery voltage.

Out of paper/door open

The printer also incorporates an optical sensor that detects when there is no paper left, or when the printer door is open. The information is passed to the Control PCA via the printer ribbon cable; the Control PCA generates the appropriate screen message and tones to alert the user.

Battery/Power Functions

Refer to Figure 6-3 for the following descriptions.

Contacts/Battery Type

The battery mates with contacts on the Battery PCA. Power from the battery flows through the Main Fuse on the Battery PCA, and then through separate wires to the Power PCA for distribution to the rest of the unit.

The Battery PCA also detects whether the installed battery is a Philips approved battery or not. It does this with a microswitch on the battery PCA, which detects if a dimpled recess is present in the end face of the battery. Philips M3516A/M5516A batteries have this dimple, while other batteries - even those that are otherwise mechanically compatible - do not.

This information is passed via a separate pair of wires to the Power PCA and from there to the Control PCA. During defibrillation, the Control PCA will direct the Power PCA to charge the defibrillator capacitor more slowly if there is a battery other than an M3516A present. This is done to reduce current drain on the battery and thus avoid tripping the thermal cutout present on many other batteries. Philips M3516A batteries do not have this cutout; so their current delivery can be greater, allowing the defibrillator to charge more quickly.

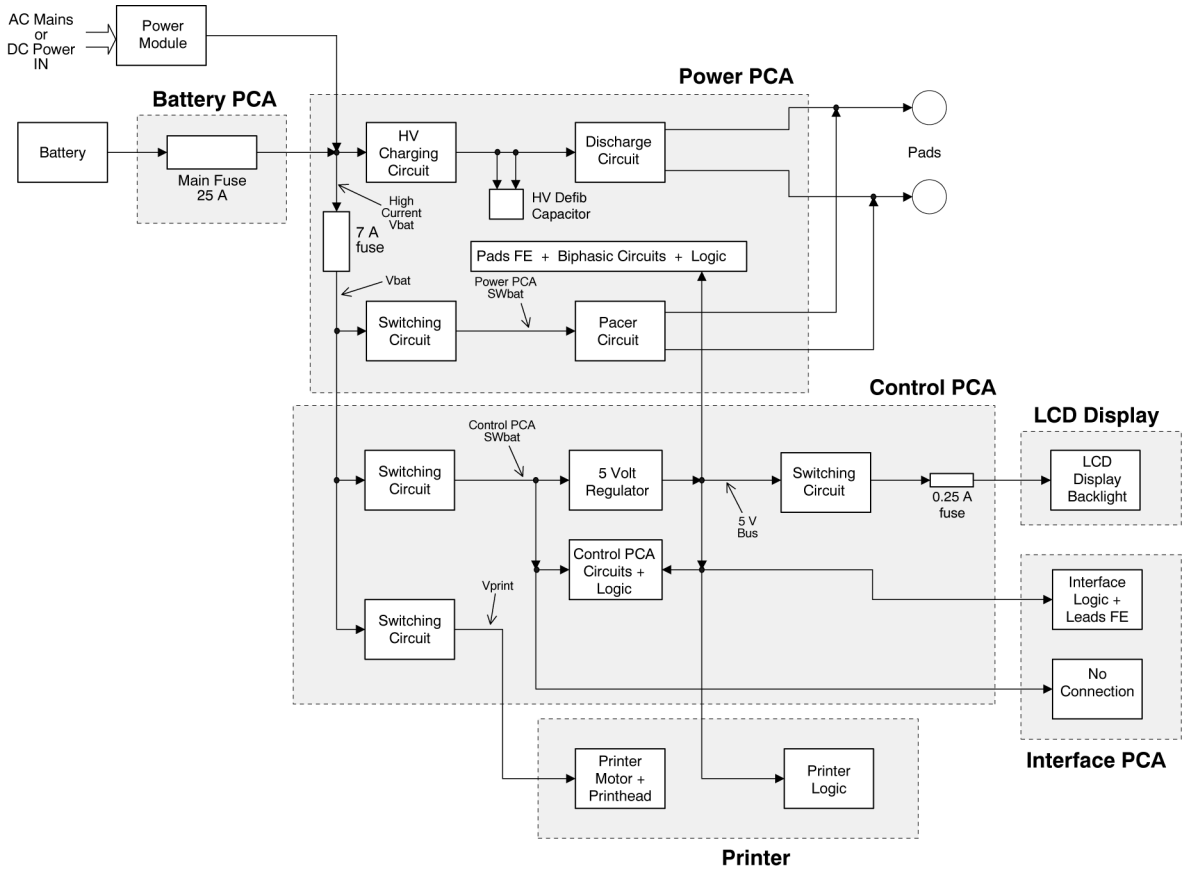
Charging

Power for charging the battery and running the unit can be supplied via the Battery Charger Connector. This power can be from either an AC Power Module (M3517A/M5517A) or a DC power Module (M3518A/M5518A). Power flows directly from the Battery Charger Connector to the Battery PCA via a separate wire pair. Instrument ground is connected to minus (-) of the Power Module output.

Monitoring the battery and controlling the charging process are both handled by the Power Module being used. The Power PCA receives status information via connections both directly to the Power Connector and to the battery. The Power PCA then sends this status information to the Control PCA via a large ribbon cable. When the unit is powered on while the Power Module is connected, the Power PCA instructs the Power Module to enter "power supply" mode.

The M3500B/M5500B uses approximately 250-400 uA of 12 V DC when powered off to maintain configuration settings, system clock, etc. When powered on in Monitoring Mode, the unit consumes approximately 400-500 mA.

Figure 6-3 Power Distribution and Fusing



Lithium Backup Battery

The Backup Battery (located on the Control PCA) provides standby power to maintain data during times when the main battery is either absent or discharged and no external power is supplied. The data maintained includes the user's configuration choices, and the system time and date.

Data Card

The Data Card allows capture of key information such as ECG waveform, shock advisories, charging, and delivering a shock. The Data Card is read by the Event Review Data Management system for post-event analysis.

CAUTION

The Data Card must only be inserted or removed when the unit's power is off. A Data Card inserted while the power is on will not be recognized by the unit. If a Card is removed while the power is on, its stored data may be corrupted and rendered unreadable.

7 Specifications

Overview

This section provides:

- Specifications for the M3500B/M5500B,
- Symbol Definitions for symbols appearing on the M3500B/M5500B,
- Safety related information, and
- Electromagnetic compatibility information.

Specifications

Defibrillator

Waveform: Biphasic Truncated Exponential. Waveform parameters adjusted as a function of patient impedance.

For details of waveforms delivered, see the "Waveforms" section of this chapter.

Shock Delivery: Via multifunction defib electrode pads.

Delivered Energy Accuracy: See Table 7-1.

Table 7-1 Delivered Energy vs. Load Impedance

Selected Energy (J)	Delivered Energy (J)					Accuracy
	Load Impedance (ohms)					
	25	50	100	125	150	
5	4.7	5	5.2	5.4	5.2	± 2 J
10	9.3	10	10.4	10.7	10.4	± 2 J
25	23.4	25	26.2	26.9	26.2	± 4 J
50	46.7	50	52.3	53.5	52.1	±15%
70	65.4	70	73.1	75.0	72.9	±15%
100	93.5	100	104.7	107.2	104.4	±15%
150	140.3	150	156.8	161.0	156.5	±15%
200	187	200	209.3	214.6	208.6	±15%

Charge Time: Less than 3 seconds to 200 Joules with a new, fully charged M3516A SLA battery pack at 25°C. Less than 15 seconds to 200 Joules when powered by a M3517A or M3518A power module with no battery installed.

Patient Impedance Range: 25 to 180 Ohm.

Manual Mode

Manual Output Energy (Delivered): 5, 10, 25, 50, 70, 100, 150, 200 Joules.

Controls: On/Energy Select, Off, Charge/Disarm, Shock, ECG Lead Select, SpO_2, HR Alarms, Exit Manual Mode, Sync, Pacer Start/Stop, Pacer Rate, Pacer Current, Pacer Mode, Display Contrast, ECG Gain, Volume, Print Strip, Print Summary, Annotated Mark Event.

Indicators: LCD display for ECG waveform and text prompts, Audio alerts, QRS Beeper, Charging Tone, Charge Done Tone, Manual Mode LED, Sync LED, Pacer LED, Printer.

Armed Indicators: Charge done tone and available energy indicated on display.

Energy Selection: Front Panel "1" key.

Charge Control: Front Panel "2" key.

Shock Control: Front Panel "3" key.

Synchronizer: SYNC message appears on the monitor and is annotated on the printer (if printing while in Sync Mode). An audible beep sounds with each detected R-wave, while a tick mark on the monitor and printed strip indicate the discharge points. Synchronizer delay is less than 60 msec from peak R-wave to peak current of the defibrillation discharge.

AED Mode

AED Energy Protocol: Fixed Energy (150 Joules).

AED Shock Series: 2, 3, or 4.

Shock Series Timer: off, 30, 60, 90, 120, 150, 180, or 210 seconds.

Text and Voice Prompts: Extensive text and audible messages guide user through protocol.

Protocol: Follows pre-configured settings. Can be configured to meet American Heart Association and European Resuscitation Council guidelines.

AED Controls: On, Off, Pause/Resume, Analyze/Stop Analysis, Shock, Lead Select, SpO_2, HR Alarms, Display Contrast, ECG Gain, Volume, Print Strip, Print Summary, Annotated Mark Event, Manual Mode Entry.

Indicators: LCD Display for ECG waveform and text prompts, Audio Alerts, Voice Prompts, QRS Beeper, Charging Tone, Charge Done Tone, Printer.

Armed Indicators: Charge Done Tone, Available Energy indicated on display, Voice Message.

Patient Analysis: Per protocol, evaluates patient ECG and signal quality to determine if a shock is appropriate and evaluates connection impedance for proper defibrillation pad contact.

Shockable Rhythms: Ventricular fibrillation with amplitude > 100 uV and wide complex ventricular tachycardia with rates greater than 150 bpm.

Sensitivity and Specificity: Meets AAMI guidelines.

ECG Monitoring

Inputs: Single channel ECG may be viewed on display and printed. PADS ECG is obtained through two multifunction defibrillation electrode pads. Lead I, II, or III is obtained through the 3-lead ECG cable and separate monitoring electrodes. With a 5-lead cable, lead aVR, aVL, aVF, or V can also be obtained.

Lead Fault: LEADS OFF message and dashed line appear on the monitor if a lead electrode or wire becomes disconnected.

Pad Fault: PADS OFF message and dashed line appear on the monitor if a pad becomes disconnected.

Heart Rate Display: Digital readout on display from 15 to 300 bpm, with an accuracy of ± 10%.

Heart Rate Alarms: Configurable pairs of low and high heart rate alarm limits: 30 to 100, 60 to 140, 90 to 160, and 120 to 200 bpm.

Defibrillation Patient Cable Length: 7 ft. (2.13 m).

ECG Cable Length: 10 ft. (3.05 m).

Common Mode Rejection: Greater than 90 dB measured per AAMI standards for cardiac monitors (EC 13).

ECG Size: 2.5, 5, 10, 20, 40 mm/mV.

Frequency Response:

AC Line Filter: 60 Hz/50Hz.

Pads ECG for Display: Monitor (.15-40 Hz)/EMS (1-30 Hz).

Pads ECG for Printer: Monitor (.15-40 Hz)/EMS 1-30 Hz).

Leads ECG for Display: Monitor (.15-40 Hz)/EMS (1-30 Hz).

Leads ECG for Printer: Diag (.05-150Hz)/EMS (1-30)/Monitor (.15-40 Hz).

Patient Isolation:

ECG: Type CF

SpO_2: Type CF

Defib: Type BF (multi-function defibrillator electrode pads)

Display

Display Size: 96 mm x 72 mm.

Display Type: Transflective active matrix LCD with LED backlight.

Display Resolution: 320 x 240 pixels.

Sweep Speed: 25 mm/s nominal (stationary trace; sweeping erase bar).

Viewing Time: 4 seconds.

Thermal Array Printer

Continuous Real Time Strip:

User starts and stops the print strip. The Print Strip prints the selected ECG lead with the following data:

HEADER 1: Date, Time, Heart Rate, the SpO_2 Value (if available), and the text "Delayed" if the recording has been configured for Delayed Mode. Prints every 12 seconds.

HEADER 2: Current mode (AED/Manual) the current Lead, the current Gain, filter setting, the text "Sync" if Sync has been enabled, and the Pacer Settings (consisting of the Pacer Mode, Rate, and Current (if currently pacing the patient). Prints every 12 seconds, with Header 1.

HEADER 3: Changes in Mode, Gain, Lead, Sync, and Pacer Settings.

FOOTER: Drug Annotations, HR/SpO_2 limits on a Limit Alarm, the Results of an Analysis in AED Mode (No Shock Advised, Shock Advised, or Cannot Analyze), Charging to xxxJ, Shock Delivered, No Shock Delivered, Disarm, Battery Low, Battery Critical.

SYMBOLS: Mark Triangle (for presses of the Mark key), an Alarm Bell (Alarm Limit Violations), Lightening Bolt (Shock Delivered), Vertical stripe Boundaries/Pacer/Sync Tick Marks).

Event Printing: Mark Event key automatically documents events and ECG during defibrillation episodes. The Mark Event key can annotate the event with one of the following labels: Epinephrine, Atropine, Lidocaine, and Other.

Auto Printing: The printer can be configured to automatically print on Mark, Charge, Shock and Alarm.

Delayed Printing: The printer can be configured to run real time or with a six second delay.

Reports: The following can be printed: Event Summary, Configuration, Extended Self Test, System Log.

Speed: 25 mm/s with an accuracy of ± 5%.

Amplitude Accuracy: ± 10% or ± 50 uV.

Paper Size: 50 mm by 30 m (100 ft.).

Battery and Battery Power Modules

Battery Type: 2 Ah, 12V, rechargeable, Sealed Lead Acid.

Battery Dimensions: 2.4" (H) x 0.94" (W) x 7.2" (D).
61.7 mm (H) x 23.9 mm (W) x 182 mm (D).

Weight: 1.4 lb. (0.65 kg).

Charge Time:

- Approximately 14.5 hours to 100%, indicated by LED on power module.
- Approximately 2.5 hours to 90%, indicated by LED on power module.

Capacity: 2.7 hours ECG monitoring or 50 full-energy discharges or 2.1 hours ECG monitoring while pacing (with a new, fully charged battery and temperature above 20^{o}C).

Battery Indicators: LOW BATTERY message appears on monitor when at least 10 minutes of monitoring time and 6 maximum-energy discharges remain (with a new battery and temperature above 20^{o}C).

Battery Storage: Should not be stored above 40^{o}C for extended periods of time.

Charger Output: Unit can be operated using Class I AC or DC power module alone with no battery installed.

Noninvasive Pacing

Waveform: Monophasic Truncated Exponential.

Current Pulse Amplitude: 10 mA to 200 mA (5 mA increments); accuracy 10 mA - 50 mA ± 5 mA, 50 mA - 200 mA ± 10%.

Pulse Width: 20 ms with accuracy +0, -5 ms.

Rate: 30 ppm to 180 ppm (10 ppm increments); accuracy ± 1.5%.

Modes: Demand or Fixed Rate.

Refractory Period: 340 msec (30 to 80 ppm); 240 msec (90 to 180 ppm).

SpO_2/Pulse Oximetry

Accuracy with:

M1191A sensor - 1 standard deviation 70% to 100%, ± 2.5%.

M1192A sensor - 1 standard deviation 70% to 100%, ± 2.5%.

M1194A sensor - 1 standard deviation 70% to 100%, ± 4.0%.

NELLCOR sensors - 1 standard deviation 80% to 100% ± 3.0%.

Resolution: 1%.

SpO_2 Alarm Limits: Three preset low alarm limits: 90, 85, and 80%, default is off.

INOP Alerts: Triggered by disconnected sensor, noisy signal, light interference or low signal (non-pulsatile).

Event Storage

Internal Event Summary:

The internal Event Summary stores up to 300 events and up to 50 waveforms.

Events can be marked with a Mark Event symbol and, if configured for drug annotation, the following labels can be added: Epinephrine, Atropine, Lidocaine, or Other.

The Print Summary key on the front panel is used to print the internal Event Summary.

Data Card Event Summary:

The Data Card stores continuous ECG waveforms and events on a Type II PCMCIA card, SanDisk SDP3B 8MB ATA FlashDisk. One 8MB card can store approximately 2 hours of continuous ECG waveforms and events.

General

Dimensions: 4.05" (H) x 11.25" (W) x 13.65" (D).
103 mm x 286 mm x 347 mm.

Weight: Standard Configuration weighs ≤ 10 lbs (4.5 kg) including battery, full roll of paper, defibrillator patient cable, 1 set of pads, and without the carrying case; with the carrying case, it weights ≤ 14 lbs (6.4 kg).

Environmental

Temperature: 0° to 50°C operating, -20° to 70°C storage.

- Thermal paper may darken above 55°C.
- Charging the battery at temperatures above 35°C may degrade battery life.
- Storing the battery for extended periods at temperatures above 40°C will reduce battery capacity and degrade battery life.
- Operating and storage specifications for electrodes may vary. Refer to the manufacturer's specifications for details.

Humidity:

Up to 95% Relative Humidity

- Printer paper may jam if paper is wet.
- Thermal printer may be damaged if wet paper is allowed to dry while in contact with printer elements.

Altitude:

- Operating: up to 15,000ft.
- Shipping: up to 20,000 ft.

Shock (drops onto concrete): Unit survives 39" (1 m) drops onto all surfaces (faces, corners, and edges) enclosed in carrying case. Exposed handle surfaces survive 24" drops.

Vibration: Mil Std. 810E 514.4 Category 6 Helicopter, General Storage, UH60.

Water Resistance: IPX4, splash proof per IEC 60529, with Data Card door closed.

Safety: Meets IEC 60601-1 (EN 60601-1), UL 2601-1,
CAN/CSA C22.2 NO.601.1

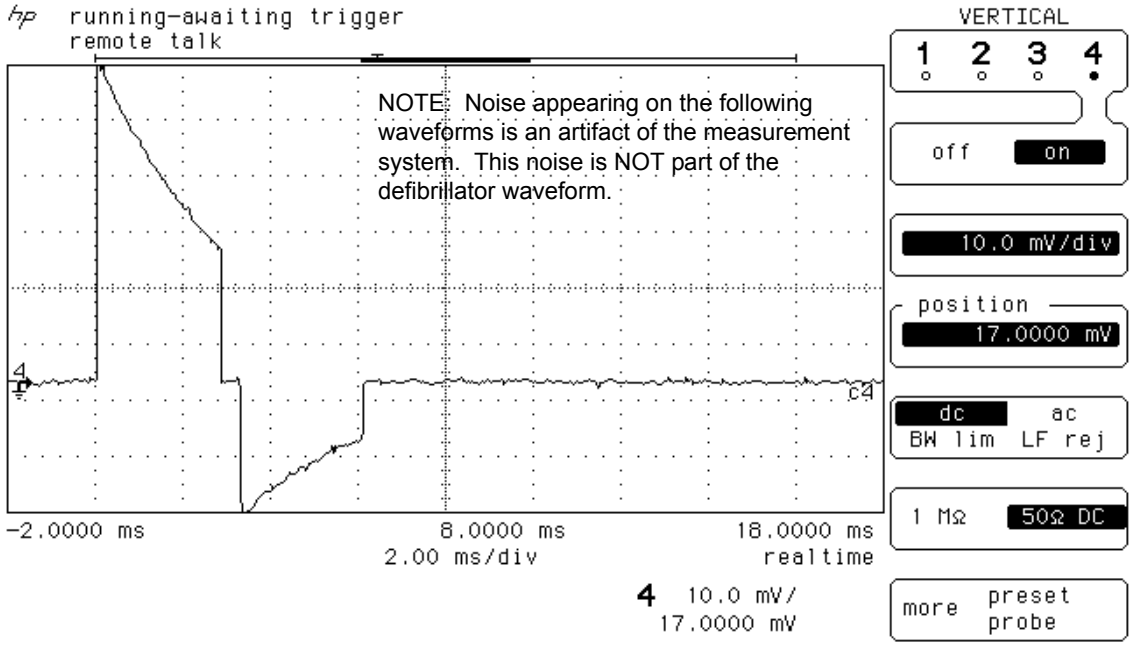
EMC: Meets EN 60601-1-2.

Other Considerations: Equipment not suitable for use in the presence of a flammable anesthetic mixture with air, oxygen, or nitrous oxide.

Mode of Operation: Continuous.

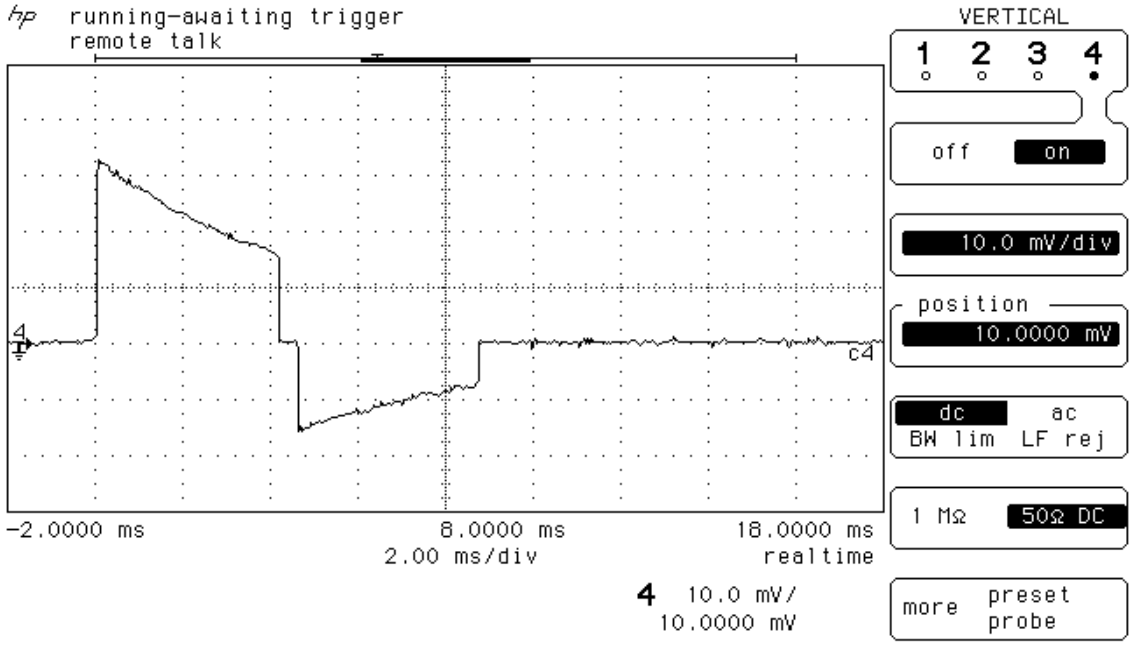
Waveforms - 150J

150J, 25 ohms



This image displays the defibrillator current waveform for a 150J discharge into 25ohms. The current probe is set to 10A/division (10A/10mV). The peak current is about 58A.

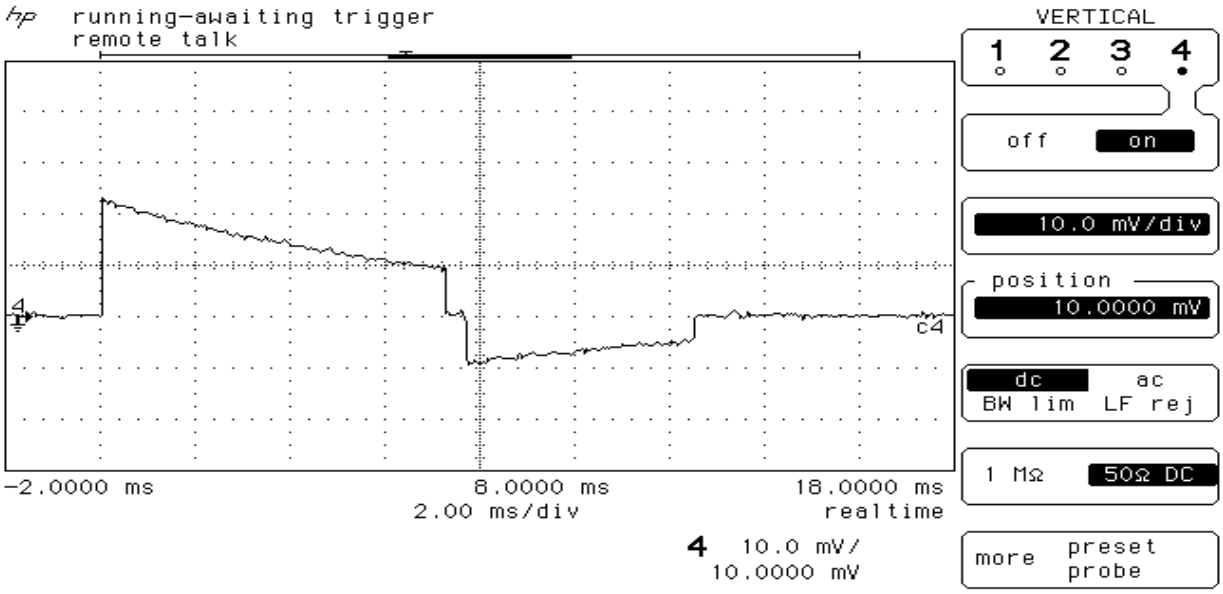
150J, 50 ohms



This image displays the defibrillator current waveform for a 150J discharge into 50ohms. The current probe is set to 10A/division (10A/10mV). The peak current is about 33A.

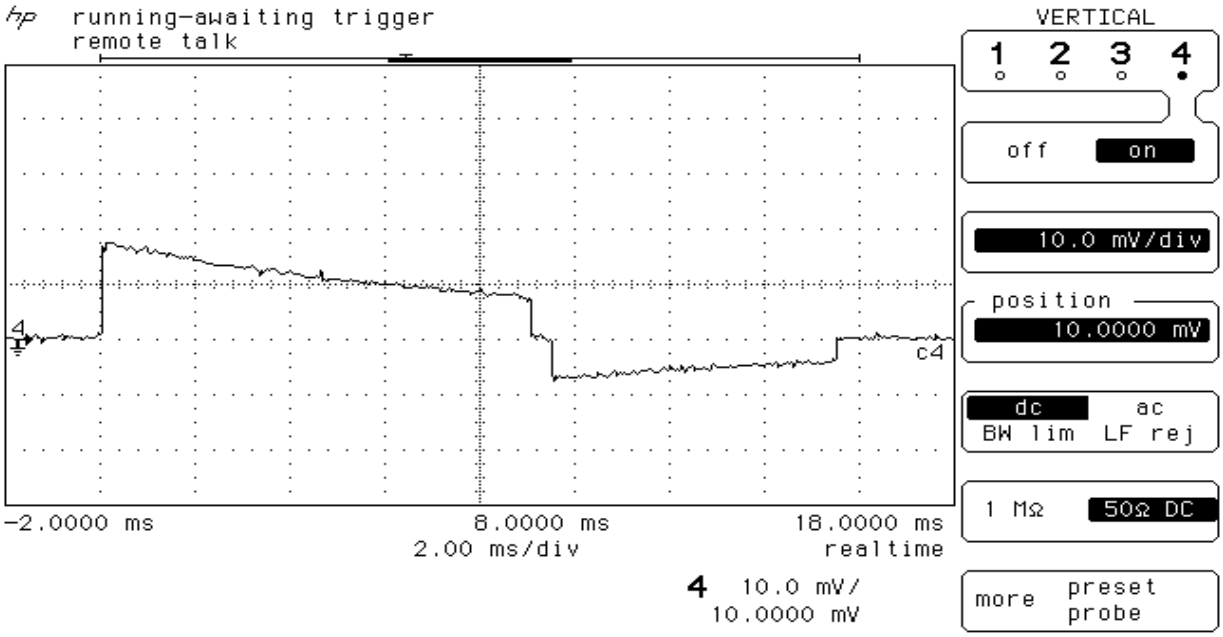
Waveforms -150J (continued)

150J, 75 ohms



This image displays the defibrillator current waveform for a 150J discharge into 75ohms. The current probe is set to 10A/division (10A/10mV). The peak current is about 23A.

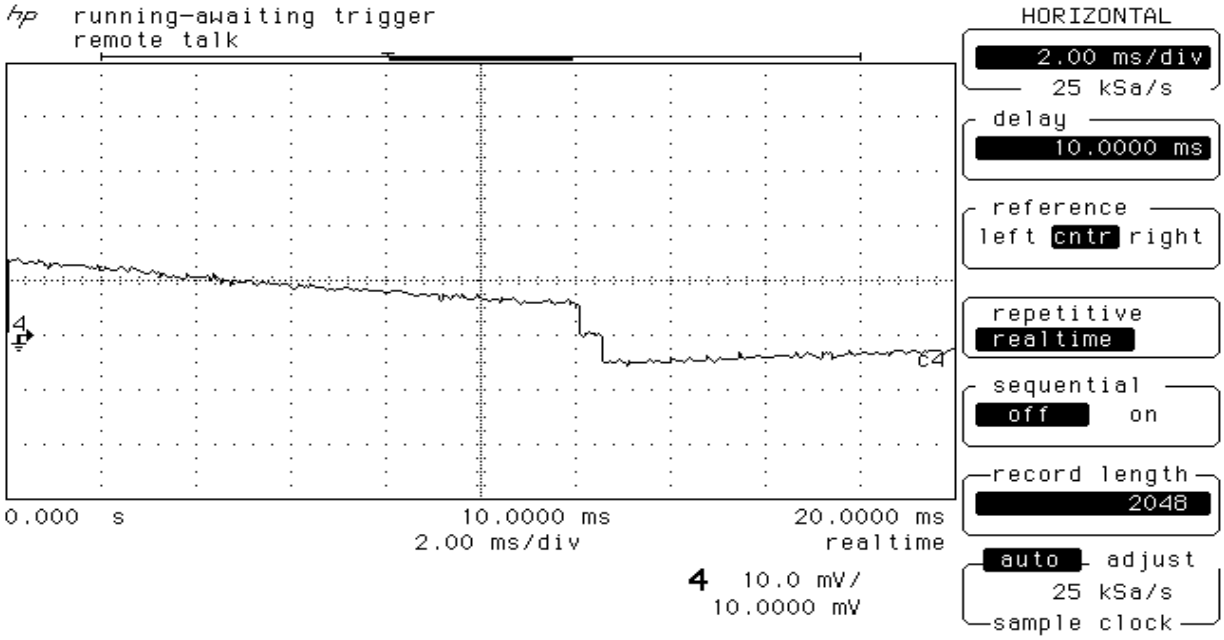
150J, 100 ohms



This image displays the defibrillator current waveform for a 150J discharge into 100ohms. The current probe is set to 10A/division (10A/10mV). The peak current is about 17A.

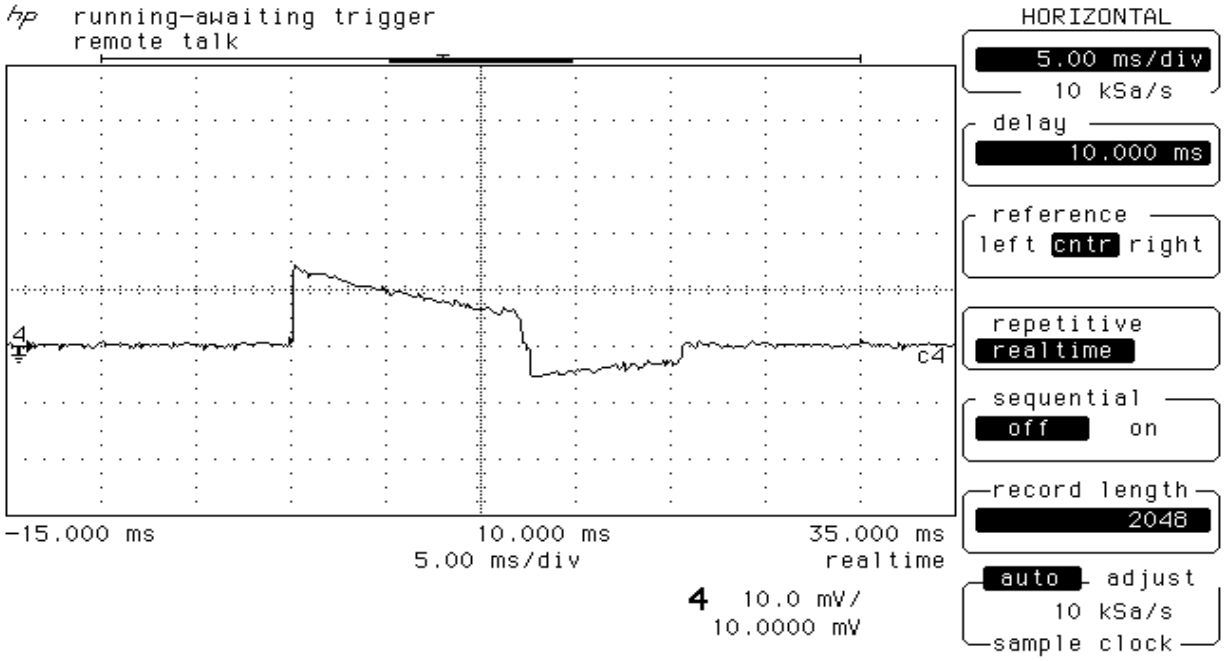
Waveforms -150J (continued)

150J, 125 ohms (2ms/div)



This image displays the defibrillator current waveform for a 150J discharge into 125ohms. The current probe is set to 10A/division (10A/10mV). The peak current is about 14A. Note that the trailing edge of the waveform is just off the right edse of the screen.

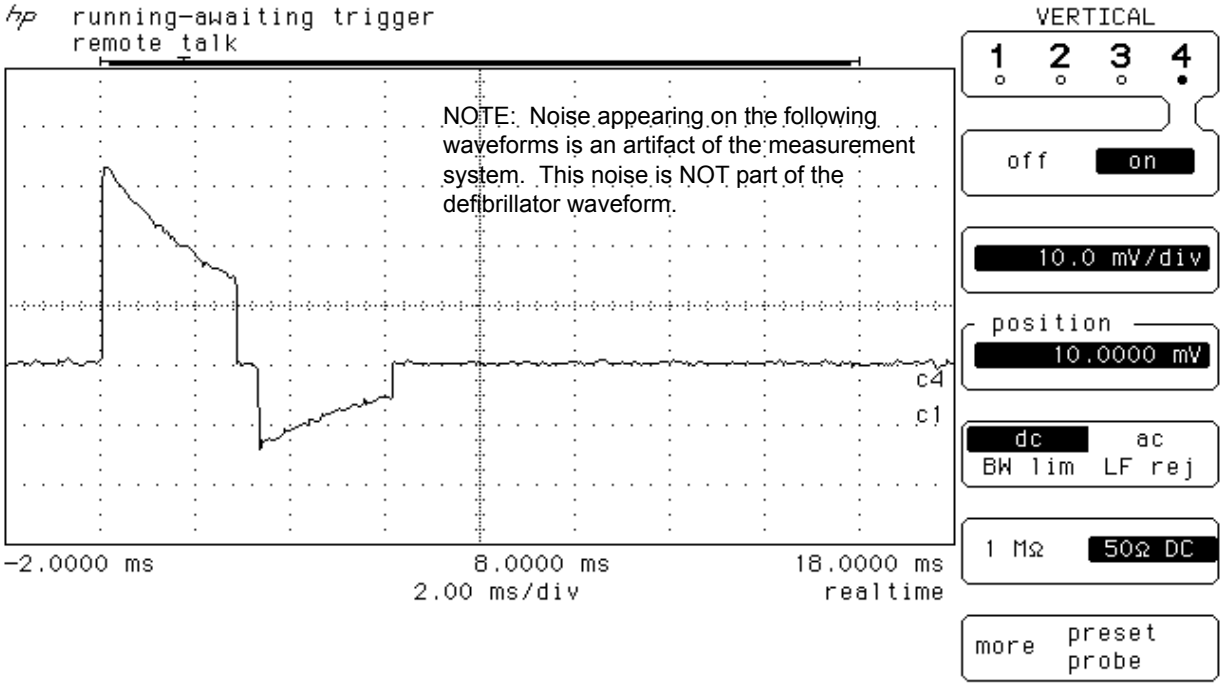
150J, 125 ohms (5 ms/div)



This image displays the defibrillator current waveform for a 150J discharge into 125ohms. The current probe is set to 10A/10mV (10A/10mV). The peak current is about 14A. Note that the timebase has been changed to 5ms/division so that the entire waveform could be captured.

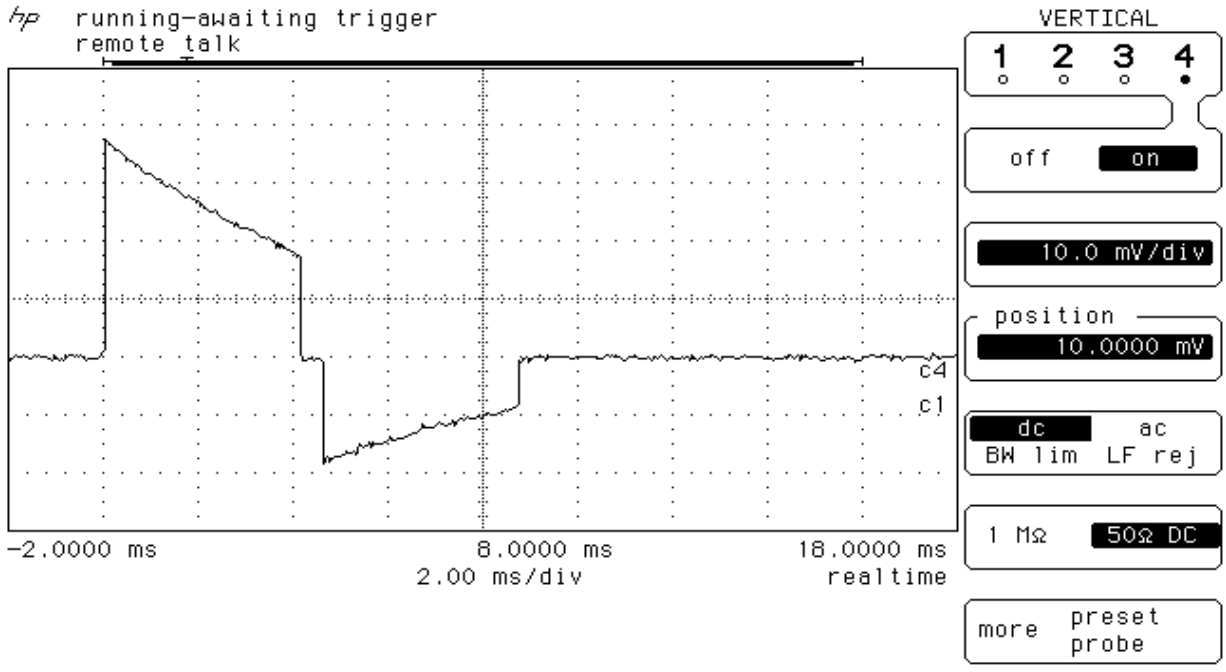
Waveforms - 200J

200J, 25ohms



This image displays the defibrillator current waveform for a 200J discharge into 25ohms. The current probe is set to 20A/div [20A/10mV]. The peak current is about 66A.

200J, 50ohms



This image displays the defibrillator current waveform for a 200J discharge into 50ohms. The current probe is set to 10A/div [10A/10mV]. The peak current is about 37A.

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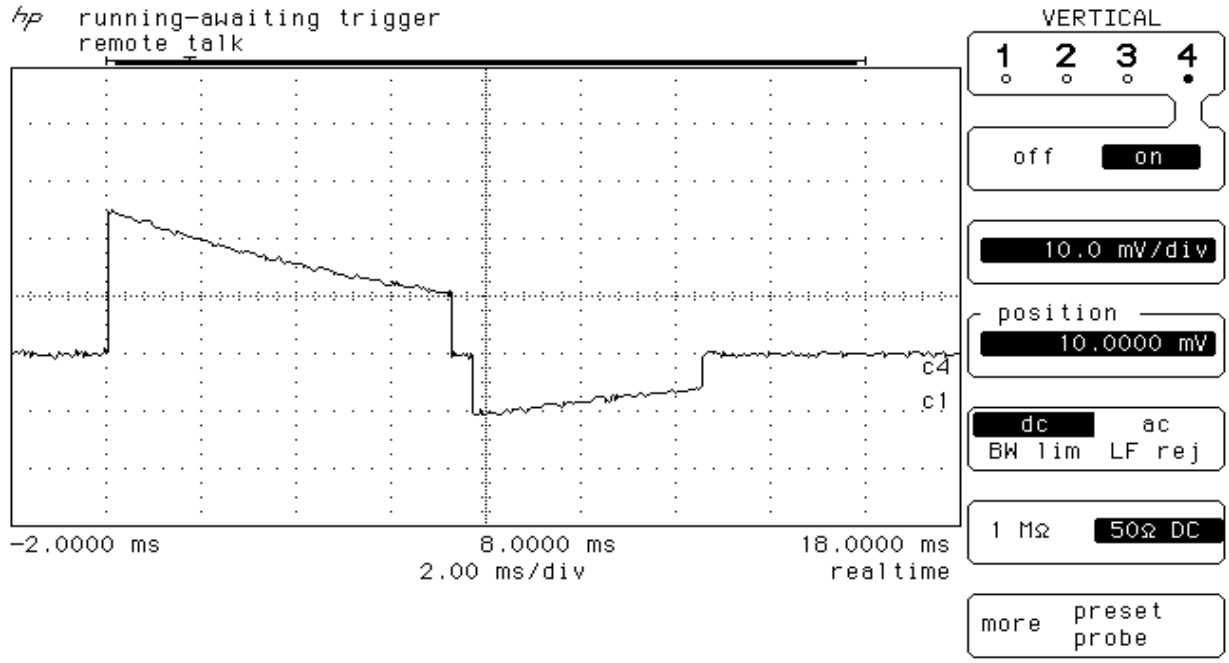
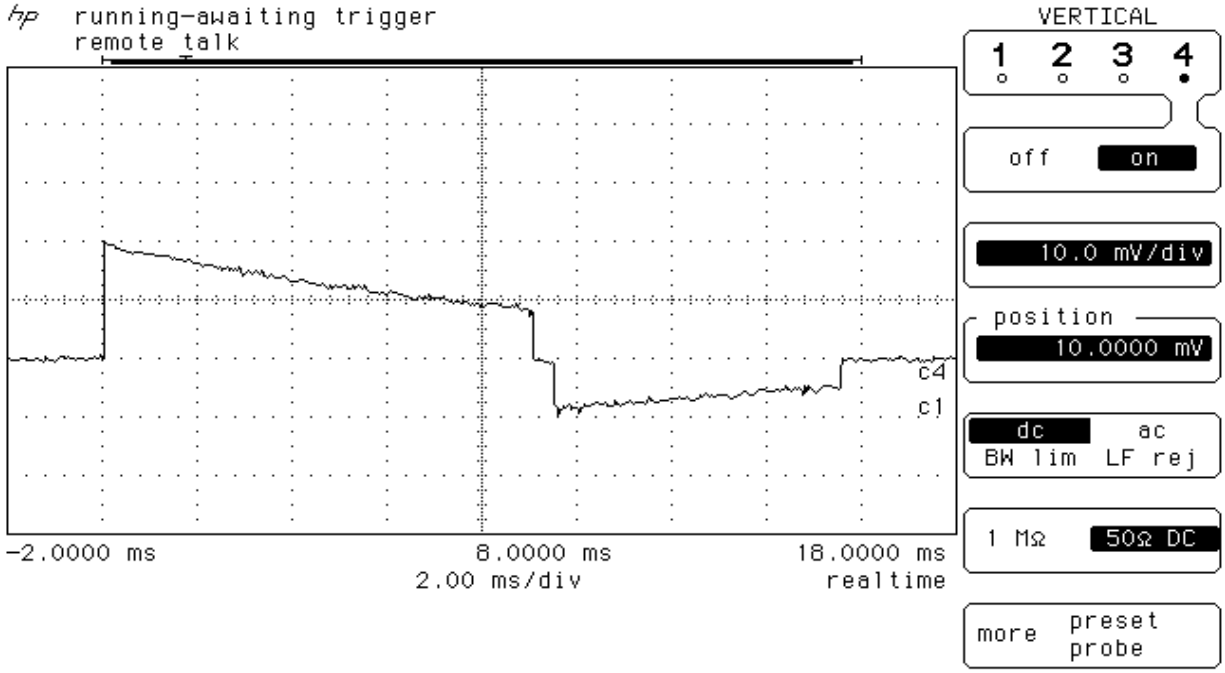
Waveforms - 200J (continued)

200J, 75ohms



This image displays the defibrillator current waveform for a 200J discharge into 75ohms. The current probe is set to 10A/div (10A/10mV). The peak current is about 25A.

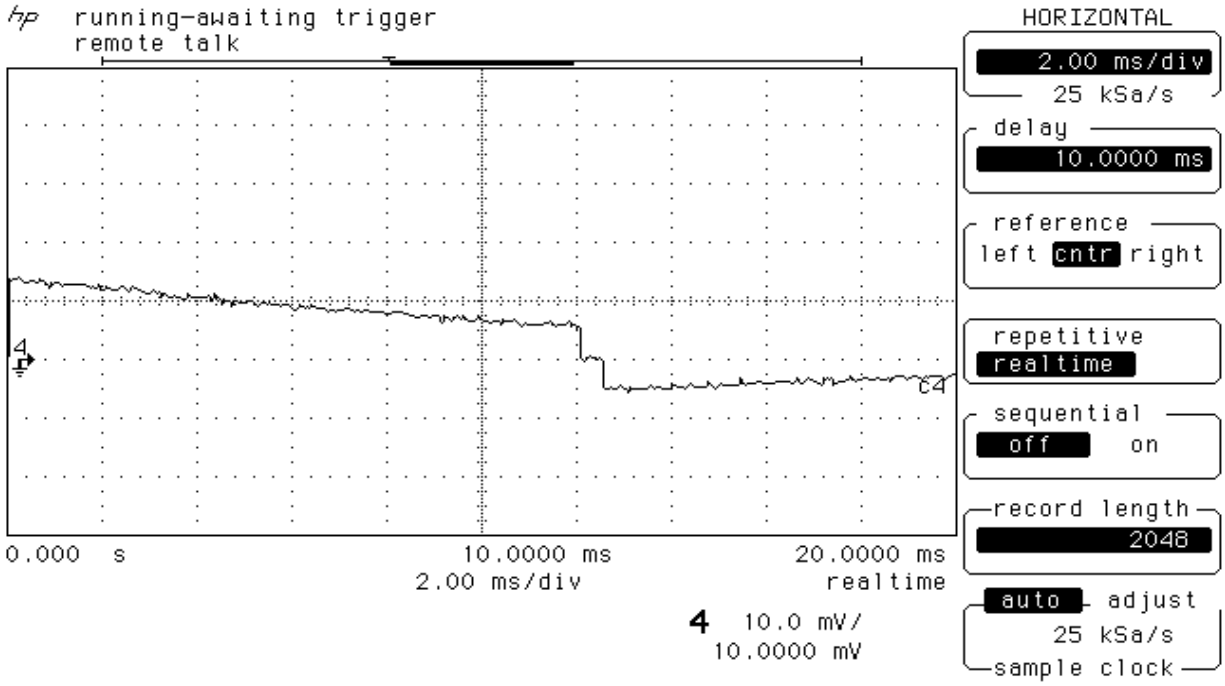
200J, 100ohms



This image displays the defibrillator current waveform for a 200J discharge into 100ohms. The current probe is set to 10A/div (10A/10mV). The peak current is about 20A.

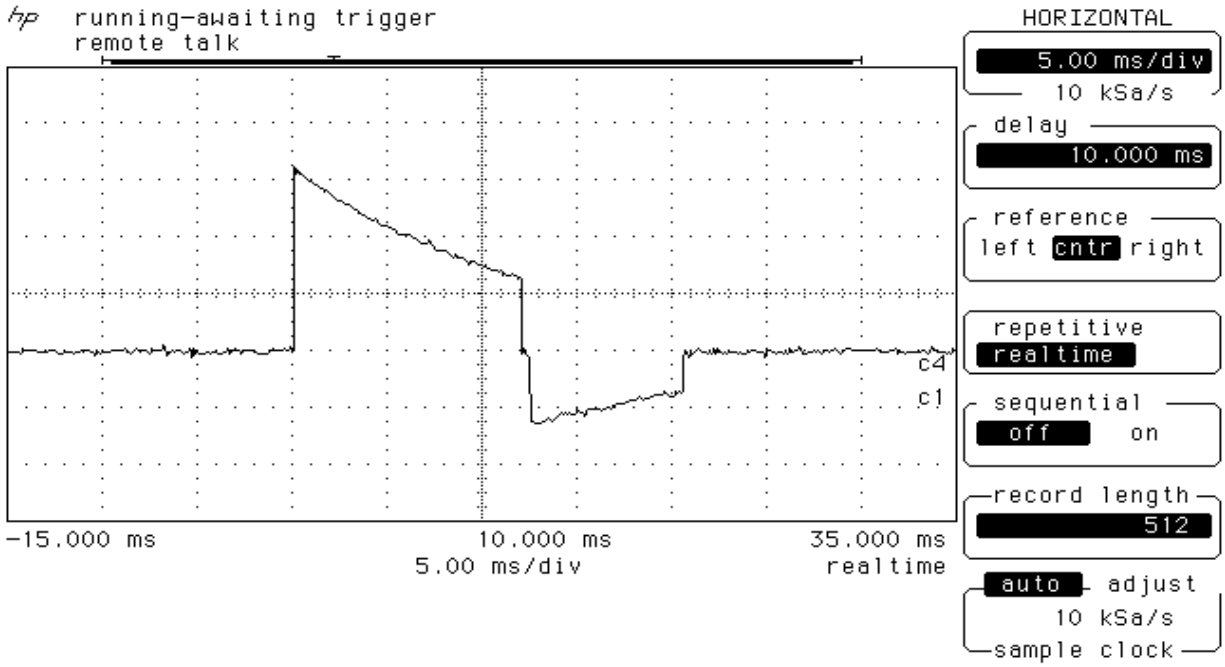
Waveforms - 200J (continued)

200J, 125ohms (2ms/div)



This image displays the defibrillator current waveform for a 150J discharge into 125ohms. The current probe is set to 10A/division (10A/10mV). The peak current is about 14A. Note that the trailing edge of the waveform is just off the right edse of the screen.

200J, 125ohms (5ms/div)



This image displays the defibrillator current waveform for a 200J discharge into 125ohms. The current probe is set to 5A/div (5A/10mV). The peak current is about 16A. The timebase for this image is 5ms/div.

Symbol Definitions

The following table lists the meanings of each symbols shown on the M3500B/M5500B and the M3516A battery:

Table 7-2 Defibrillator and Battery Symbols

Symbol	Definition
	On.
	Off.
	Shock hazard.
	Caution - See operating instructions in ***Instructions for Use***.
	Power module input.
	Input
	Meets IEC type BF leakage current requirements and is defibrillator protected (Patient Applied Part is isolated and defib-proof suitable for direct patient contact except the heart or major arteries.)
	Meets IEC type CF leakage current requirements and is defibrillator protected (Patient Applied Part is isolated and defib-proof suitable for direct patient contact including the heart and major arteries).
	Alarms are active.
	Alarms are inactive.
	Recyclable material.
	Must be recycled or disposed of properly.
	Unlock.
IPX4	Ingress of fluids classification; protected against splashing water.

The following table lists the symbols that appear on the M3500B/M5500B shipping carton:

Table 7-3 Shipping Carton Symbols

Symbol	Definition
	Atmospheric pressure range.
	Temperature range.
	Relative humidity range.
	Recyclable paper product.
	Fragile.
	Right side up.
	Do not get wet.
	Shelf life.
	Long-term storage conditions.
	Short-term transport storage.

Safety Considerations

The following general warnings and cautions apply to use of the M3500B/M5500B. Additional warning and cautions specific to a particular feature are provided in the appropriate section.

WARNING — *The M3500B/M5500B is not intended to be deployed in settings or situations that promote use by untrained personnel. Operation by untrained personnel can result in injury or death.*

WARNING — *Remain attentive to the patient during the delivery of therapy. Delay in delivering a shock may result in a rhythm that was analyzed as shockable converting spontaneously to non-shockable and could result in inappropriate delivery of a shock.*

WARNING — *Use only the multifunction defib electrode pads, battery, and accessories listed in the **Instructions for Use**. Substitutions may cause the M3500B/M5500B to function improperly.*

WARNING — *Use multifunction defib electrode pads prior to their expiration date. Discard pads after use. Do not reuse pads.*

WARNING — *In AED Mode, the multifunction defib electrode pads must be in the anterior-anterior position as shown on the packaging. The M3500B/M5500B was not designed to assess data acquired from pads in an anterior-posterior position.*

WARNING — *Do not allow multifunction defib electrode pads to touch each other or to touch other ECG monitoring electrodes, lead wires, dressings, etc. Contact with metal objects may cause electrical arcing and patient skin burns during defibrillation and may divert current away from the heart.*

WARNING — *During defibrillation, air pockets between the skin and multifunction defib electrode pads may cause patient skin burns. To help prevent air pockets, make sure the pads completely adhere to the skin. Do not use dried out pads; do not open pads package until just prior to use.*

WARNING — *Never touch the patient or any equipment connected to the patient (including the bed or gurney) during defibrillation.*

WARNING — *Do not operate the M3500B/M5500B in standing water. When using the M3500B/M5500B in wet environments, make sure the Data Card door is securely shut.*

WARNING	*Do not immerse, or pour fluids on, any portion of the M3500B/M5500B.*
WARNING	*Do not use the M3500B/M5500B in a flammable or oxygen-rich atmosphere. This can cause an explosion hazard.*
WARNING	*Avoid connecting the patient to several devices at once. Leakage current limits may be exceeded. Do not use a second defibrillator on the patient while pacing with the M3500B/M5500B.*
WARNING	*Avoid contact between the patient and metal objects, such as the gurney. Contact with metal objects could cause unintentional current pathways.*
WARNING	*Operating the M3500B/M5500B or its accessories in conditions outside the environmental specifications can result in device or accessory malfunction.*
WARNING	*Avoid exposing the display to direct sunlight on a hot day. Overheating can occur and cause the display to black out, making the M3500B/M5500B temporarily unusable.*
WARNING	*Medical electrical equipment which does not incorporate defibrillator protection should be disconnected during defibrillation.*
WARNING	*Electric shock hazards exist internally. Do not remove assembly screws. Refer servicing to qualified personnel.*
CAUTION	This device has not been evaluated for use with electrosurgery equipment.

Electromagnetic Compatibility

When using the M3500B defibrillator/monitor (with or without the M3517A AC Charger), electromagnetic compatibility with surrounding devices should be assessed.

A medical device can either generate or receive electromagnetic interference. Testing for electromagnetic compatibility EMC) of the M3500B with and without the appropriate accessories has been performed according to the international standard for EMC for medical devices (IEC 60601-1-2). This IEC standard has been adopted in Europe as the European Norm (EN 60601-1-2).

The EMC standards describe tests for both emitted and received interference. Emission tests deal with interference generated by the device being tested. According to the EMC standards, the M3517A AC Power Module does not generate interference.

WARNING

Radio frequency (RF) interference from nearby transmitting devices may degrade performance of the M3500B/M5500B defibrillator/monitor. Electromagnetic compatibility with surrounding devices should be assessed prior to using the defibrillator.

Reducing Electromagnetic Interference

The M3500B defibrillator/monitor and M3517A AC Charger are susceptible to interference from other RF energy sources and continuous, repetitive, power line bursts. Examples of other sources of RF interference are medical devices, cellular products, information technology equipment and radio/television transmission. Should interference be encountered, as demonstrated by artifact on the ECG or dramatic variations in SpO_2 values, attempt to locate the source. Assess:

- Is the interference intermittent or constant?
- Does the interference occur only in certain locations?
- Does the interference occur only when in close proximity to certain medical devices?
- Does the SpO2 value change dramatically when the M3517A AC Charger is unplugged?

Once the source is located, attempt to attenuate the EMC coupling path by distancing the defibrillator from the source as much as possible. If assistance is needed, call your local service representative.

Restrictions for Use

Artifact on the ECG caused by electromagnetic interference should be evaluated by a physician or physician authorized personnel to determine if it will negatively impact patient diagnosis or treatment.

Immunity Level

The EMC standards state that manufacturers of patient-coupled equipment must specify immunity levels for their systems. It is recognized that the M3500B/M5500B defibrillator/monitor is designed to receive and amplify low level signals in the same bandwidth as the interference.

Immunity is defined in the standard as the ability of a system to perform without degradation in the presence of an electromagnetic disturbance. Degradation in ECG quality is a qualitative assessment which can be subjective.

Caution should, therefore, be taken in comparing immunity levels of different devices. The criteria used for degradation is not specified by the standard and may vary with the manufacturer.

NOTE

For additional information about compliance with the EMC standards, visit our Medical Systems website at www.medical.philips.com/cms and follow the link to Regulatory.

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